ENGINEERING

An Illustrated Weekly Journal

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ASSEMBLING A KELVIN DOUBLE BRIDGE

Nurnberg photograph for ENGINEERING

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AWAY FROM THE OFFICE

MR. HENRY LUCE, of *Time* and *Life* fame, told his fellow business managers at the conclusion of a congress in Paris last week that the philosopher and practical man must work together. It was an idealistic chord he struck in the minds of the audience. It was also a realistic chord—a C major so to speak—as a similar outlook had been revealed by two other practical men. Mr. Louis Armand, President of the French National Railways, had devoted much of his address at the opening of the Congress to the philosophy of management. And during the congress, Lieut.-Colonel L. F. Urwick, in an address on F. W. Taylor—" the father of scientific management "—had said that it was Taylor's " philosophy, his concepts of what business was about and how it should be conducted, which he regarded as his enduring contribution to society." Though Taylor made this clear in 1912, he probably did not use the word " philosophy " in this context. It has taken a couple of generations for his misunderstood views to be accepted as normal. Meanwhile, new kinds of vision have been grafted into managerial thinking. The men who give the rest of us a lead are generally practical men of affairs—as Taylor was—but they have this remarkable ability to open our eyes to a new way of seeing. They have the magical power of the artist, enabling us to see familiar things in a new light.

More people are managers than are aware of it. Apart from the posts which contain the word in their titles, like works manager and sales manager, manager is a word that is likely to arouse a vague sense of " I know what a manager is but I am not one of them." In fact, practically everyone carrying some kind of responsibility in industry and the public service is a manager. If he is concerned with the direction of other people's talents or the employment of machines, materials and the like, he is a manager. The difference between the leaders in management and those of average ability is that the leaders discard the blinkers of their youthful specialisation and become conscious of their managerial function and opportunities quicker than the others. They refuse to be bowed down by the routine duties of their work; they make time to get away from the confining effect of the office—literally by going out and about, and figuratively by looking at the world of events outside through their reading and thought.

Mr. Armand said that he made a practice of thinking very freely. To him the real significance of the Industrial Revolution is that it led to a general overhaul of all our thinking. And the revolution in thinking continues. To him the world of contemporary ideas is of significant and practical importance in business and public affairs. He likened these ideas to the leaves on a tree—in their time they nourished the tree but even when they had served their immediate purpose and had fallen to the ground they were the means of fertilising the next season's growth. So ideas in organisation and management have their immediate uses, and as they die away they give life to the new ideas.

The significant thing about this incessantly active structure of ideas is that it never enters a works or an office, or an individual mind, uninvited. Go out physically and intellectually from the office and you are subjected to a part of its multiple bombardment. At international congresses such as that reported on the next page, you enter an area of dense bombardment. It is not just the formal papers and addresses, it is much more the result of participating in the collective thinking and talking. It is highly stimulating and productive of ideas. That only a few of the ideas are eventually put to practical use is of no consequence. Conferences on a national or regional basis are in some ways more rewarding than international meetings since they are more concentrated in subject-matter and delegates. The British Institute of Management conferences are of incalculable value in this country.

The men who attend these congresses are generally of two types: the chairmen, managing directors, presidents and vice-presidents of companies, together with the heads of state industries; and the younger men who are well-known authorities in specialised fields. As for the first type, it is a moot point whether they find time to be at the congress because, being such important people, they have large staffs who can carry on while they are away, or whether they have got where they are because they early learnt the trick of finding time for extra-office activities. The specialists are extremely fortunate because at a comparatively early age they have been initiated into the world of ideas. It is significant that both types invariably come from the more progressive firms and organisations. They come, in a sense, to check up on their own performance using that of other firms as a standard. At an international congress they can make comparisons with organisations in the leading industrial countries—which is particularly helpful to representatives of the underdeveloped countries.

It is ironical that the men on the shop floor who have no managerial responsibilities are sometimes natural philosophers, though, because of their limited education, they are naturally restricted in their outlook. It is because they have no managerial responsibilities—because their minds are unfettered

—that they can devote some time to thinking. The creative men of our generation are those who, in spite of daily administrative pressure, keep some part of their time, some part of their minds, for the changing world of ideas and events outside. Unquestionably, the future rests with those who are scientific in their understanding but philosophers at heart.

* * *

Plain Words

The fearful warnings were justified after all. "The machine is made for man," they said, "not man for the machine." And we laughed it off as the ignorant forebodings of ignorant laymen. We quoted the bit about harnessing the power of nature for the use and convenience of man, and pressed on with our greater productivity, our atoms for peace, our automation for shorter working hours and leisure for all. But they were right.

They were right because now it is abundantly clear that the experts in some of the newer sciences that probe beneath our skins are ganging up so that they can modify our physical and mental powers and render them more suitable for the machines of the future. As the review of a book on page 16 shows, the apparent intention is to develop our powers to the fullest extent. But basically, the aim is to make us fit the machine. We are not suitable in our present form. Our reaction time may be too slow; we may be too timorous. Man is to be made for the machine.

How foolish we were, not to foresee it. For a generation now a selected few have been segregated and then given intensive training for handling the latest in aeroplanes, tanks and the like. Then, quite recently, didn't we ourselves study the design of machines in relation to the characteristics of the human body? We brought in the psychologists and the physiologists and between us we found the way to design dials that were easier to read, controls that were easier to control. Obviously it was but a short step from that to the idea of training men who would be better at reading dials and manipulating controls.

We may not live to see the ultimate development in this direction, but our children will. It is disquieting to think that they will probably regard it as a normal stage in the progress of mankind. But at least we can set down our views here and now, in the hope that one of them will turn up this issue of ENGINEERING. Let us solemnly state (they will doubtless think it funny) that, in our view, British Standard specifications should deal only with material things, not with men. Rue the day when the B.S.I. publish a new standard, B.S. No. ???:(1984?), "Engineers, male, electrical: Physical, mental, and other characteristics." All the fun of job-hunting will vanish when men reply to: "Engineer wanted for secret work; must conform to B.S. ...." We—we happy people—don't know the extent of our powers.

Delegates arriving for the opening session of the International Management Congress at Paris last week.

THE CREATIVE MEN OF OUR TIME LOOK ABOUT THEM

Men who direct and manage the affairs of great enterprises, men whose vision leads them on the path of innovation—these stand out as the commanding powers of our generation. They have one characteristic in common—they look out beyond the confines of their offices and factories to the crowded world of ideas and events outside. How they do it is discussed in a leading article on page 1. The kind of ideas they find are described in the following notes. They look outside . . .

To Educate Themselves

Typical of the breed were the men—over twelve hundred of them—who attended an International Management Congress in Paris last week. They came from European countries, from Britain, from the Americas, from the Far East, from Australia and New Zealand, to exchange ideas and gain mental refreshment from new contacts. In short, they came to educate themselves.

They were rewarded by a group of papers and discussions on various aspects of scientific management, and by addresses from four internationally famous figures—Mr. Henry R. Luce, Editor-in-Chief of Time-Life Inc., Lieut.-Colonel L. F. Urwick, the British authority on the practice of management, Mr. Louis Armand, the President of the French National Railways and one of the "Three Wise Men" of Euratom, and Mr. John Diebold, who early in his life has achieved distinction as a practical interpreter of automation.

The difficulties encountered by mature managers in wishing to educate themselves came out in a report by Professor Hans F. Schwenkhagen of Western Germany. Men in their late thirties or early forties who come together on management courses have such varied backgrounds and education that it is not easy to prepare a suitable curriculum. In practice the organisers sometimes compile a full list of topics from which a careful selection is made to suit the interests and requirements of each course. On the other hand it is far easier for men with managerial experience to study management subjects and gain benefit than for young men who have had no chance to gain such experience. There is an air of realism with the older men that is inevitably lacking with the younger ones.

In North America the average age of those attending management courses is 40. In other countries it is rather lower—about 35. The length of the courses varies widely, but the average is 4½ to 5 weeks. In nearly every country the initiative for starting courses has come from industry rather than from government direction. This interest on the part of firms has helped considerably in popularising them, but even so there are psychological barriers to their fuller use. Words like "education," "training," "course," do not help; hence the use of words like "conference." In the United States and Britain the courses (or conferences) are well patronised, but elsewhere they have to be sold to prospective clients. It was, of course, in the United States and the United Kingdom that the movement first got under way. Other countries are following suit. There is a growing desire among managers to educate themselves. As young men they thought of themselves as engineers, accountants, etc.; never as managers. When, however, they wake up to the fact that they have organising and administrative responsibilities, they are eager to fit themselves for their new role.

To Educate Their Juniors

But some part of management techniques and practice must be imparted to the young entrant to industry. At university or technical college he learns a little of the vast amount of management knowledge that has been built up in the last few generations. But it is not until five to ten years after graduation that really effective education for management can take place. Most countries reported the difficulties experienced in sparing junior and middle grade managers for training. This is felt particularly in the smaller countries, in contrast to the policy, formulated by the very large companies, of insisting that a certain proportion of the staff will always be away on courses.

Assuming that arrangements have been made to spare a young manager, the task of the course organisers is that of "de-specialising the specialist." At the course (or conference) the aim is not so much to impart factual knowledge of management techniques as to convey ideas and concepts. One speaker pointed out that

we have a long way to go before the psychologists and anthropologists produce for managers the kind of useful data that physicists and mathematicians have given the engineer. But the pace at which this new information is becoming available is increasing.

For Guidance in Their Responsibilities

The concluding remarks of Professor Schwenkhagen were on one of the major objectives of education for scientific management. He warned the packed hall that it was necessary to form the student's attitude " towards business and life in such a way that he is fully aware of the responsibilitity he bears towards his neighbour who is given to him as a subordinate, as a competitor or as a customer." If, however, scientific management education resulted in forming a responsible group of managers of to-morrow, this group may perhaps be " the rightful substitute for the peers and nobles of yesterday, leading human society into a prosperous and happy future always knowing that their main task is leadership."

These words expressed very well the mood of the delegates, who looked to the speakers, and to one another, for guidance in their responsibilities. Would the future, in fact, prove to be a prosperous and happy one? Few of the leading figures of management assembled in Paris belittled the size of the task that awaited managers as automation spread and developed during the next decade. It would be management under conditions radically different from those operating to-day. The change had barely begun, and it was about this change that there was the sharpest clash of opinion of the whole congress. One school of thought, represented by Peter Drucker, John Diebold and others (mainly Americans), saw in automation a radically new concept for making things, which would demand new attributes on the part of both management and workers, but one which in no way threatened the social welfare the world had demanded so loudly and grabbed so eagerly after the war.

Mr. Diebold saw " in the phenomenon of automation " a major new problem for management but essentially one of how to get the best out of a great technical step forward in production methods. Although he thought that management " has not faced up to this problem and is not even grappling with it in any true sense." he and Mr. Drucker dismissed contemptuously the contention that automation " is primarily useful as a labour-saving device."

The intense interest taken in the controversy between this point of view and that of Professor Fred L. Polak, who argued strongly that automation was a threat to full employment, showed that a keen sense of social responsibility prevailed among the delegates—Americans as well as Europeans—who had experienced the onset of automation. Professor Polak's paper, " The problem of maintaining continuous and full employment," is a masterly review of world developments in this field. His case for the contention that automation is " a potential factor in unemployment " and a danger " as a social-cultural automatism " (in the sense that it demands, except from a small fraction of those employed, even less skill and provides less variety and work interest for operatives than machine-minding) is disturbing. It is no " back-to-nature " nonsense. He merely says that there is no room for complacent beliefs that employment will be increased rather than decreased and that all and sundry can be re-trained. Like Diebold and Drucker, Polak takes the new concept most seriously and accepts its inevitability: " automation may form a threat, but non-automation is now also perhaps an even greater threat-"

For Essential Information

Several of the papers read to the Congress indicated a new concern on the part of management to have a reliable factual background to their expressed policy. The pre-occupation with the newer techniques in management research, such as Operational Research, for example, and O.S.T. (not so new, perhaps, but still in its toddling stage), did not prevent delegates from listening to papers on the role of market research in assessing trends in business, industry and the national economy, and on the exchange of essential information between trade associations, firms and government departments. The first was by Professor G. Tagliacarne, general secretary of the Italian Association of Chambers of Commerce, Industry and Agriculture, and president of the Italian Association of Market Research. Professor Tagliacarne concentrates on collective market research, as might be undertaken by trade or professional associations, chambers of commerce or public administrations on behalf of their members or of whole sections of manufacturing industry. He gave some twenty examples of such market surveys, ranging from a survey of smoking commissioned by the Italian Government to one on trade fairs carried out regularly in Germany on behalf of exhibitors.

This concentration on collective surveys tends to exclude the fields of capital or investment goods in which, as Professor Tagliacarne himself points out, " surveys are hardly ever made by associations." A great deal of the information contained in the paper is of necessity rather general, and concerns consumer goods which, in the metals and engineering industries, consist of household appliances, cycles, cars, garden and home workshop equipment and other products purchased and used by the private citizen for his own ends. The omission of capital goods left a gap which was not adequately filled by subsequent discussion of Professor Tagliacarne's paper, although contributions from Germany and France produced a number of valid generalities concerning the objectives of capital goods market research. The main interest in the paper was the evidence offered that collective market research has made considerable headway on the Continent and in the United States, and that a steady flow of knowledge is now being brought to the surface.

The collection of market statistics, which is in all countries an expensive and laborious process, would be simplified a great deal if, in the words of Professor Tagliacarne, " business and professional associations could undertake . . . persuading their members to communicate statistical data about their concerns (orders received, output, sales, etc.)." An interesting paper was contributed on this subject by Professor Frank Sewell Bray, Stamp-Martin Professor of Accounting and a senior research associate in the Department of Applied Economics, Cambridge. Professor Bray restricted his contribution to " how to raise managerial effectiveness through inter-firm comparisons " and " how to make the collection and provision of government statistics less burdensome and more useful to management." In this he received the co-operation of other experts and organisations in ten countries, including the United States and Germany.

The conclusions are strongly in favour of a freer and more comprehensive interchange of information between firms, for " inter-firm comparisons make it easier for managements to manage " and represent " a modern tool of management which no progressive industry or firm can afford to disregard." The proposals for the setting up of a European Free Trade Area (mentioned only rarely during the official sessions of the Congress but a frequent subject of conversation in the corridors) make desirable " comparisons between firms in different countries in Europe " to provide the essential information on cost structure which would enable a smoother transition to a free market. Perhaps not enough was said on market research or information exchange, but " essential information " was very much on the agenda of the Congress. The growing complexity of marketing and merchandising, the difficulties of planning production and investment and the darkness that still surrounds many industrial activities make it one of the most important subjects dealt with during this hectic week.

For the Magic Touch of Operational Research

The most challenging and at the same time the most disturbing development in the new tools of management is undoubtedly Operational Research. " Challenging " because it demands an exceptional readiness to devote time and intellectual energy to mastering the methods and possibilities of O.R. " Disturbing " because the application of O.R. to a business or an aspect of a business is likely to upset the delicate balance of organisation which has probably been achieved over a long time by patient and careful study. It is likely to present management with the prospect of fundamental improvements in organisation but the decision to take the plunge is not easy.

In a sense O.R. is only an extension of scientific management, just as automation can be regarded as an extension of mechanisation. But neither statement gives the whole truth. O.R. makes use of such varied and advanced branches of science, and in such a noval way, that it invests its practitioners with altogether new powers. The title of the paper at the Congress was " Scientific Preparation for Decisions "—which is as near as one can get to a short definition. The author was Mr. Melvin L. Hurni of the General Electric Company, New York.

O.R. was started in Britain during the last war, mainly for solving problems of strategy and logistics. The British delegates were therefore interested to hear of the use other countries have made of it. Among the countries which were able to report progress were—apart from the United States—Australia, Belgium, Canada, Denmark, France, Germany, Italy, Spain and Sweden. Industries in these countries have employed it chiefly for attacking isolated problems such as the optimum geographical arrangement of warehouses, the inability to manufacture the right model of product at the right time, etc. In Britain, however, O.R. has been used for such nationally important questions as the importation of iron ore and the decision to build a £60 million extension to a steelworks. In Britain there is a flourishing Operational Research Society.

Mr. Hurni referred to O.R. as a new discipline that can increase our understanding and knowledge of a business and its environment in its entirety—" a discipline capable of describing business phenomena in more concise terms than are now available to us as managers, and hypotheses or models for making more explicit the risks, opportunities and conditions for achievement associated with various courses of action and for evaluating the elements in such courses of action that lead to either success or failure. Mathematics is the main agent in O.R., but various sciences are also used.

The price that O.R. demands is, as Mr. Hurni remarked, that " we are not going to have something handed to us without considerable effort on our own part." It is not usually possible to hand over a problem to an O.R. expert and tell him to get on with it and produce the answer. Managers must actively participate—which is tantamount to saying that a great opportunity awaits anyone who can make the time available and apply his energies to it in relation to his own business.

For Simplification

The case for the simplification of the work involved in producing the world's requirements was argued by a Swiss engineer, Mr. Paul Fornallaz, who was a pupil and is now a teacher at the Swiss Federal Institute of Technology in Zurich. Some measure of the interest in the subject of his paper, " Effects of work simplification and standardisation in improving productivity and the means of measuring produc-

tivy," is the considerable support Mr. Fornallaz found in thirteen countries, including an outstanding contribution from France. This was prepared by a study commission of the Comité National de l'Organisation Française, presided over by Mr. Jean Mongon, manager at the Société de Constructions Electriques et Mécaniques " Alsthom."

The paper and subsequent discussion dealt with the evolution of manufacturing techniques and the part that can be played by simplification —of the product and of production methods and processes—and by standardisation in securing economies in manufacturing costs and the use of materials. The figures quoted by John Diebold to the effect that 80 per cent. of all United States production is in lots of 25 identical pieces or less were strikingly supported by figures quoted by Mr. Fornallaz—that out of 64 million working people in the United States, only a maximum of 3 million, barely 5 per cent., " perform chain work or execute a strongly repetitive work of a superior type." In Europe the proportion of people concerned with the first four types of production—free hand, with a few simple tools; simple machine work; flow production (by hand or by machine); and semi-automatic machine work—is even greater, probably over 90 per cent. Mr. Fornallaz therefore concentrated on the prospects of applying work simplification in these fields. The others—automatic machine work (operator controlled); "chain" production; and automatic operation, control and adjustment (automation) —are excluded from his analysis and review.

The merit of this paper lies in the facts it gives under several fairly weather-beaten headings, such as " work simplification," " method study," " work measurement," and the like. European industry (and management consultants) should draw comfort from the fact that we have barely started to move in the general direction indicated. A valid criticism is that the space devoted to the simplification of manufacturing methods is out of proportion to the scope offered by the simplification of the product and of the distribution and maintenance tasks. There lies a source of economy probably greater than any other, since much of the work put into producing more simply an unnecessarily complicated product can be entirely wasted.

Product simplification invariably means redefinition, " after research, creation and adjusting." The French contribution typically points out that few products can be right if they are not beautiful. All clumsy, heavy pieces with ugly protruberances and inartistic shapes are immediately suspect. An aesthetic form can generally be obtained, by economising in the means and materials used; " useful beauty " thus achieved by simplification increases the value of the product. There is a great deal of sense in this attitude.

In practice, no company's range of products should be allowed to escape close scrutiny and criticism. To have predetermined times, technological times, relaxation times and various other means of getting a workshop working well is not enough, for a company stands or falls on products not on methods of production.

For the Meaning of Automation

Much that was authoritative and well-informed was spoken on automation during the course of the Congress. Professor Polak's warning of the social evils it may beget was a healthy counter to the cheerful predictions of the eminent United States authorities on the subject, John Diebold and Peter Drucker. All three left the delegates no room to doubt that a revolutionary change in production methods had taken place since the early 1950's. Mr. Diebold is the youthful president of the largest management consulting firm in the United States specialising in the field of automation, automatic data processing, management science and their application to industry. His book, *Automation: The Advent of the Automatic Factory*, published in 1952, was the pioneering work in the introduction of the possibilities of what he describes as " a new technology," a " new concept—the idea of self-regulating systems—and a new set of principles." Mr. Drucker's latest book, *The Practice of Management*, indicates, as he underlined personally at the Congress, that he shares Diebold's beliefs at least in broad outline. On the meaning of automation, in so far as it has acquired definable meaning, Diebold's paper to the Congress, " The development of automation in industry," was a major contribution.

Above all else, and before it is anything else, he argues, automation is " a concept or way of approach in solving problems . . . it gives the means to build new kinds of machines to perform many new tasks in a wide range of enterprises." As a word it is only about ten years old, and already " there is almost a folklore of automation; most management thinking is cluttered with a whole set of stereotypes." Mr. Diebold in his paper, and Mr. Drucker in his lively interventions, did their best to sweep away the stereotypes. Few of those who listened and pondered on what they heard could any longer be content with the " push-button type of thinking " which has been characteristic of the first decade of automation.

Nothing could be further from the truth than the belief that automation is limited in its applications to companies with large financial resources and exceptionally long runs of products The motor vehicle industry has had great success under those conditions, but large transfer machines are not suited to 80 per cent. of American industry that produces in lots of 25 or fewer identical pieces, or for industries that frequently redesign their products. The type of automation involving large transfer machines with loading and unloading devices is inflexible and suitable only " where literally millions of identical parts pass through a line before new equipment has to be considered." Mr. Diebold's belief that this is a very narrow view of automation is well expressed in the following quotation from his paper:—

" But the new technology of automation that deals with feedback and control systems is producing a new family of machines guided by magnetic or punched paper tape. These machines will make it possible to obtain the benefits of automatic production, yet retain the flexibility of operation essential for job shop production. They are only beginning to appear. Some 40 different prototypes can to-day be found in the shops of machine tool manufacturers and during the next few years they will begin to have an enormous impact on the small lot producers of this country. It is my own conviction that these tape controlled machine tools are to-day undergoing the same evolutionary step that computers were between their inception in 1946 and their emergence *en masse* and wide application following 1950. I believe that during the next three years we will witness large-scale shipments of numerically controlled machines and their emergence as a major new standard equipment in our factories."

The third stereotype, considered by Mr. Diebold to be the most pernicious of all stereotypes about automation is, primarily, its usefulness as a labour-saving device. This has already been discussed in relation to Dr. Polak's paper. His conclusion is that " more efficient operation and better control are the next goals. If labour is saved as a by-product, so much the better." The fourth and last stereotype discussed by Mr. Diebold is that " because automation is highly technical it must be left to the technicians." There he is concerned more with the implementation of policy and the use made of computers than with the social implications of the changed methods. His advice on planning, staffing, costing and training has the ring of experience. Much has been said in this paper which is eminently worth reading, especially if Diebold and Drucker are right in their contention that automation makes possible the production, at low cost, of variety. This is of the greatest significance for British industry.

Letters to the Editor

DAY OF ADJUSTMENT

SIR, Your comments in Plain Words last week on the engineering graduate touches on one of the problems of the young graduate entering industry. The gulf between Graduation Day and the apprenticeship does indeed involve a change in attitude to life. The wide contrasts between the apparent inefficiency of the factory and the idealism of the university, between the manual labour and the intellectual study, and between the 7.30 and 5.00 clocking in and out and the freedom of a college routine need to be reconciled.

But for those who have chosen to throw in their lot with the engineering industry this reconciliation comes as a challenge (unless they retire to the shelter of research). The broader view of life which should come from a university education ought to go a long way to meeting this challenge.

This country is in great need of technically qualified men, but it requires also that they be whole men, men with the vision to see where they are going and to see some order and purpose in life. The purpose of a university course for an engineer is surely to help fulfil this need.

If, as your remarks suggest, the graduates of our great universities are unable to make this adjustment, then it seems we must leave it to the rougher life of the provincial university to furnish us with a philosophy of life which is both more realistic and more responsible than that implied by your closing phrase.

Yours faithfully,

CYRIL MARKHAM, B.Sc. (Tech.).

Sale,
Cheshire.

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HIGH SPEED RESEARCH

In the June 7 issue of ENGINEERING, in Plain Words, we raised three questions: " Does the abandonment of specific supersonic projects mean that a halt has been called to high-speed research and development of aircraft? Is Great Britain to drop out of the race for optimum performance? Has the curtain been dropped on aeronautical progress? "

It seems, happily, that the answer is No. In officially opening the Royal Aircraft Establishment's high-speed research facilities at Bedford on June 27, the Minister of Supply, Mr. Aubrey Jones, said that the United Kingdom cannot afford to withdraw from the struggle for air supremacy—not only because it is an essential element in military strength, but also because of its fertilising influence on other industries. Mr. Jones, in fact, suggested that unless the country kept its place in the forefront of aeronautical engineering, it would be difficult to hold ground in general engineering. For these reasons, the momentum of aeronautical research had to be maintained.

Further points from his speech reveal, however, that the Government are expecting a greater financial contribution towards the cost of research from the aircraft industry. Whereas, a few years ago, research investigations undertaken on behalf of the industry, although willingly performed by the Royal Aircraft Establishment, were regarded as a hindrance to vital long-term research projects, to-day the Government are inviting the industry to call on the high-speed facilities.

Hitherto, the development of civil airliners in this country has always been subsidised in the sense that, in performance, they were always some few years behind their military contemporaries and were, in fact, based on data obtained from earlier defence research. To-day, with ambitions soaring towards a supersonic airliner, but with no comparable military project in view, the aircraft industry will have to participate in long-term research on a much larger scale.

CIVIL ENGINEERING IN MILITARY INSTALLATIONS

EXHIBITION OF ROYAL ENGINEER WORKS SERVICES

At the War Office in London a very interesting exhibition of models and photographs illustrating activities of the Royal Engineer Works Services was shown to the Press on June 20. The Works Services branch of the Royal Engineers may be described as the building agents for the British Army. The branch is an integrated organisation of military and civilian personnel which includes directing staffs, architects, civil, electrical and mechanical engineers, quantity surveyors, clerks of works, and administrative staffs. Among its functions are to offer technical advice on building and engineering problems to the Quartermaster General and his staff, to develop designs, plan projects, prepare contracts, supervise work to completion, and exercise control over funds allotted for projects.

As the War Office exhibition showed, much of the work is concerned with designing and providing accommodation for the British Army throughout the world. Such accommodation includes a varied assortment of buildings, ranging from barrack blocks and married quarters through office blocks, schools, and hospitals to boiler houses and garages. Nearly all designs are based on agreed inter-service scales approved by the Treasury, and incorporate the best modern building, engineering and electrical practice commensurate with economy.

The current Army Estimates show that the total estimate for larger works to be started in the financial year 1957-58 is £23,491,000. By " larger works " is meant new works, alterations, and special repairs estimated to cost £10,000 each and upwards. The amount represents the cost of the services, whether performed by contract, by directly employed civilian labour, or by military labour, including the value of all stores consumed from army stocks; it excludes, however, the cost of military staffs employed by the Royal Engineers on the supervision of works services, the cost of military labour, and the cost of certain civilian supervisory staffs, which are provided under other headings. Of the total estimate of £23,491,000, the amount voted in 1957-58 is £11,920,000, which compares with £13,730,000 voted in 1956-57. Much of the money goes for installations abroad, the £23,491,000 total being divided as to £14,090,000 for larger works at home, and £9,401,000 for corresponding works abroad.

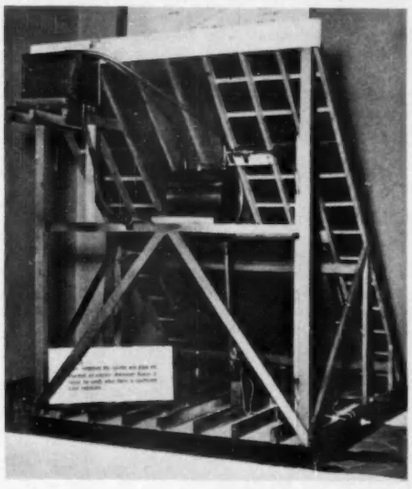
Among enterprises with an engineering interest illustrated at the War Office exhibition, three are described below.

SEWAGE DISPOSAL WORKS, CYPRUS

This installation will serve the whole British Army cantonment at Episkopi, on the south coast of Cyprus west of Limassol. Sewage will flow into the works from the 12 in. diameter sewer crossing Happy Valley and from the 6 in. diameter sewer from the vortex chamber taking its flow from the Paramali Forest area farther west. The flow passes through two comminutors, which have a screen by-pass for emergency use in the event of electricity failure or repairs to the comminutors, and thence through a recorder to the pumping station. The crude sewage is then pumped to four upward-flow sedimentation tanks, and from these the settled effluent gravitates through an inverted syphon to two syphon chambers and then through four filters. The filtered effluent flows through an open channel to four humus tanks, and from them passes to the ditch.

On the outlet side of the humus tanks provision is made for passing up to half the humus tank effluent to the pumping station for recirculation (*a*) for controlling the fly nuisance, or (*b*) to cope with a load greater than that for which the works have been designed, or (*c*) for irrigation purposes. If full recirculation should be required for an increased load, the number of humus tanks will be increased at a later date. The recirculation pumps are not provided under the present contract.

The sedimentation-tank sludge gravitates to the pumping station through a 6 in. diameter pipe, and from there is pumped to the sludge digestion tanks. The chamber at the inlet side of the sludge sump has been designed so that sedimentation-tank sludge can pass direct to the sludge beds if the sludge pump should fail. The digested sludge from the sludge digestion tanks gravitates through the same pipe to the sludge beds. By virtue of the chamber at the inlet side of the sludge sump, part of the digested sludge can be pumped back for re-seeding the tanks.



The back of the Army's solar water-heater, showing the immersion heater for use in periods of little sunlight.

Decanted liquor from the sludge digestation tanks, together with filter wash-out liquor, humus tank sludge, and sludge-bed liquor, gravitates to the crude sewage sump at the pumping station for return to the sedimentation tanks.

The pumping station contains three crude sewage pumps, each rated at approximately 1½ times the dry-weather flow (i.e., two pumps together equal three times the dry-weather flow), and one sludge pump; provision is also made for the installation at a later date of three recirculating pumps, referred to above.

SOLAR WATER-HEATER

In 1954 a solar water-heater on the lines of the model shown at the War Office exhibition was designed in the Directorate of Fortifications and Works in collaboration with the Deputy Director of Works, Middle East Land Forces. This water-heater was built and in March, 1955, was put up in F[illegible].

The apparatus consists of 5 ft. by 5 ft. absorber panels laid at an angle to the horizontal and facing south. The sun heats pipes built into the absorber, and the heated water then rises to a hot-water cylinder. Alternatively, the water can be heated by an immersion heater if need be. The rest of the system is similar to domestic hot-water systems for houses. The illustration is by courtesy of *Soldier*, the British Army magazine.

In the experiment at Fayid three 5 ft. by 5 ft. absorber panels were used. Calculations were based on heating 60 Imperial gallons a day from 70 deg. F. to 140 deg. F. Records show that for about six months from May to October the sun carried all the heating load. During this period the water temperature averaged 150 deg. F. from two o'clock in the afternoon until the evening draw-off of water started. There are no records for the winter period as the apparatus was removed and taken to Cyprus in November, 1955.

While the installation was at Fayid a family of four had more than enough hot water for six months at no running cost. Taking electricity at 2·6 pence per unit, it is calculated that an average user (9 kWh a day) would spend £36 a year on a full electric system, whereas £10 would cover solar heating together with electricity for water-heating during months of cold and cloudy weather. In addition, the saving of electricity required for water-heating must be considered; in certain circumstances this can be an important factor.

After the successful experiment at Fayid a second prototype solar water-heater was designed and upwards of a hundred were ordered for installation in married quarters in Cyprus.

POTTON ISLAND BRIDGE

Potton Island bridge, crossing a creek in three spans with a total length of 352 ft., links an island in the Thames Estuary with the Essex shore. The bridge is approached by embankments constructed from consolidated excavated material and metalled. It has two prestressed concrete spans of 110 ft., and a central steel swing span of 120 ft. cantilevering from a central supporting pier in the middle of the river. All piers and embankments are supported by piles driven through the mud to an underlying layer of ballast. The prestressed concrete spans are fixed on rocker and roller bearings to allow freedom of movement both horizontally and vertically. The steel swing span is electrically operated, automatically interlocked, and controlled from the warden's office on the island side. The span pivots about a central bearing, the drive being effected through two vertical pinions working on a circular rack. In its closed position it is supported and locked on six steel wedges which are operated by hydraulic rams.

The bridge provides for a 16 ft. 6 in. roadway designed for normal Ministry of Transport loading and for 30 ton tanks which may be loaded on a transporter. The slewing span permits free navigation of the river and provides a 50 ft. navigable channel.

* * *

FROM THE WORLD LOOKING OUT

It looks as though the radio telescope at Jodrell Bank will be working within the next few months. Thus it could take part in the work of the International Geophysical Year, which started on July 1. However, it is unlikely that it will play a very active part, because its superiority over other radio telescopes lies in its ability to investigate cosmological problems rather than geophysical ones. As Professor A. C. B. Lovell, who is in charge of research at Jodrell Bank, said, " Its true role lies in the exploration of outer space." The telescope certainly will not be idle once it has been finished. A 24 hours a day programme has been drawn up for it.

The consulting engineer to the project, Mr. H. C. Husband, put the total cost of the telescope and its ancillary buildings at £750,000. The Nuffield Foundation and the Department of Scientific and Industrial Research have provided £600,000 of this. Where the remainder is coming from is still under consideration. Manchester University, the owners of the telescope, are anxious to have complete control over the uses to which it is put. A detailed description of the project will be published shortly in ENGINEERING.

Weekly Survey

Cover Picture: *The Kelvin double bridge measures very low electrical resistance with precision. Among its uses are the calibration of meter shunts and the measurement of resistivity. It is a development of the Wheatstone bridge that eliminates the errors caused by lead resistance and contact resistance. The range of measurement is from 10^{-7} ohm to 11·1 ohm. The resistance elements are of aged Manganin—selected for negligible resistance variation with temperature, and low thermo-electric e.m.f. A feature of the instrument is the use of an oil-immersed slide wire.*

* * *

Commonwealth

The Commonwealth Prime Ministers' conference has had a significant agenda before it over the last week or so. On the political side it has welcomed new Prime Ministers from Canada and the new Dominion of Ghana in West Africa. There are also a number of vital topics to be discussed on defence. Since the last Commonwealth meeting, this country has completely changed its thinking on the relationship between nuclear and conventional armaments, while the Suez incident, which is not now likely to be a major irritant at the meetings, has exposed certain shortcomings even on the tactical use of conventional weapons as thought out in the decade since the war. On the economic side, there may well have been some plain speaking about the future of the Sterling Area.

It was expected that this last problem would play a smaller part in the Commonwealth deliberations than had at one time seemed likely. It remains, however, a matter of importance and urgency. Since the war this country, India and Australia have all made heavy calls on the central reserves for reasons which can be attributed at least in part to internal economic policy. The presence of Ghana underlines the need to establish some clearer rules about the terms on which, and the circumstances under which, raids can be carried out by a Dominion in its own interests. Ghana has for long been a major contributor to the Sterling Area with no direct say in how the reserves may be used. This is now changed and it is time to re-write the rules of the club for the information of the new member and the better disciplining of some of the older ones.

Not all the Dominions are members of the Sterling Area of course but the two non-members, Canada and South Africa, have an interest in seeing that this side of the Commonwealth's activities does not become a breeding ground for disunity. It is not likely that the communiques at the end of the conference will be particularly informative, to judge from past experience. It is to be hoped, however, that behind the facade of generalisation about Commonwealth unity there will have been an exchange of practical recipes on good housekeeping.

* * *

And Commonweal

The much pilloried and, perhaps, inevitable movement towards freer world trade is giving rise to a good deal of apprehension concerning the established pattern of trade within the Commonwealth. In a series of recent publications, the Central Office of Information place the facts before us and thus dispel some of the more common misgivings. One booklet, *Consultation and Co-operation in the Commonwealth*, describes the machinery which has been evolved over a long period for consultations between the nine sovereign countries and their dependencies. The basis of this is a free and continuous exchange of views through periodical meetings of ministers and officials and the activities of a number of specialised organisations such as the Commonwealth Agricultural Bureaux, the Commonwealth Air Transport Council, Shipping Committee, Telecommunications Board and others. A leaflet entitled *Quotations on the Commonwealth* brings together important statements by those who played a prominent part in the development of the Commonwealth idea, beginning with the Marquess of Hastings, Governor General of India in 1818. Quotations from Commonwealth leaders since the war provide an excellent picture of present-day relationships and functions.

The likely impact of the Free Trade Area proposals on Imperial Preference is analysed in a C.O.I. report of that title. It lucidly summaries the development of trade restrictions, which culminated in the Import Duties Act of 1932, and brought about the Ottawa Agreements in the same year (forming the basis of Imperial Preference). The post-war spate of bilateral trade agreements and the parallel liberalisation of world trade under the sponsorship of G.A.T.T. are examined, as are the Common Market and the Free Trade Area. Their relationship to Commonwealth trade, are also briefly discussed.

* * *

Wages and the Free Trade Area

One of the pillars of the Treaty of Rome establishing the European Common Market is the "harmonisation" of wages and working conditions. This was written into the Treaty at the insistence of the French along with an agreement on equal pay for equal work as between men and women. The idea is, briefly, that over a period of time the cost of wages and working conditions should be equalised between the same industries in different countries so that there is no danger of a low-cost country exporting its low standard of living to workers who are already enjoying a high one.

The French have let it be known that they consider this condition for participation just as important in the Free Trade Area as in the European Common Market. When the time comes they may give way somewhat, and indeed there is a school of thought which thinks that the French insistence on these clauses in the Treaty of Rome was due to the pressure of public opinion as mobilised by the Press rather than to the insistence of any French industry or group of government officials.

A publication called *Freer Trade in Europe* put out by the Treasury last week (H.M. Stationery Office, price 2*s*. net) brings together some interesting data on wages and working conditions which has been prepared for the International Labour Office. An index number based on approximate information on working conditions shows this country to be favourably placed compared with Scandinavia, Switzerland, France and Belgium but to be adversely placed compared with Germany, the Netherlands, Italy and Austria. These figures agree with the general impression so far, and if "harmonisation" means in practice, as it surely must, that wages and working conditions will tend to move towards the highest and best, this country is fairly well placed. It is as well that this should be so for those trade unions which have examined the matter in this country have left no doubt that they will oppose any "harmonisation" agreement at government level which may be subsequently imposed on industry. In their view the bargaining on this question is a matter between industries and unions without government interference.

* * *

European Gas Industry

A useful addition to the documentation available on European industry is the first Annual Bulletin of Gas Statistics for Europe issued by the Economic Commission for Europe at the end of May. This is stated to be the first publication in which gas statistics have been compiled from both Eastern and Western European countries. Statistics for 1955 are complete from 21 countries covering gas production, industrial exchanges, trade, stocks and consumption, gas distribution and industrial consumption of gas. Figures for years prior to 1955 are given for some countries only, but the E.C.E. Secretariat hope to publish statistics for 1956 by the autumn of 1957 and it will eventually be possible to compare trends over a period of years.

Perhaps the most interesting table is that showing industrial consumption of gas in the principal European countries. The figures are divided into natural gas, gas derived from the gas industry proper, from other coal carbonising industries and from other industries. The greatest industrial use of gas occurs in Western Germany (11,010 million cub. metres in 1955) followed by Italy (7,482 million cub. metres), the United Kingdom (7,220 million cub. metres) and Belgium (3,734 million cub. metres). There are, however, important differences between these countries. In Western Germany, for example, nearly 90 per cent. of the industrial consumption of gas is derived from "other coal carbonising industries," mainly coke ovens, while in the United Kingdom 62·5 per cent. of the total is provided by the gas industry proper and the balance mainly from coke ovens. In Italy natural gas accounts for nearly 90 per cent. of the total but in Belgium the most important source is "other industries" including blast furnaces and oil refineries, which account for 65 per cent. of the total.

There are some important gaps in the statistics: for example no figures are available showing the breakdown of consumption by industries in the United Kingdom, though such figures are available in greater or less detail for most other European countries. The statistics in the bulletin were obtained in answer to a questionnaire prepared jointly by the E.C.E. Secretariat and the International Gas Union and possibly the grouping of a large number of countries in a single publication will stimulate those whose statistics are at present incomplete to remedy this deficiency.

* * *

Coal and Steel Giants in Europe

When the treaty setting up the European Coal and Steel Community was signed five years ago two of its longest articles dealt with monopolies and concentrations. How successful has the High Authority been in keeping down the size of its member firms? By American standards it has done very well. United States Steel produces 30 per cent. of their national production and Bethlehem another 20 per cent. Before the war the Vereinigte Stahlwerke controlled 40 per cent. of German steel and 20 per cent. of her coal. To-day it takes ten companies to account for 37 per cent. of steel production and 20 to make 61 per cent. The biggest firm in the Community only produces 2·7 million tons out of 56·75 million tons a year. In Germany no single enterprise claimed more than 13 per cent. of the national total. In France the figure was 15 per cent. In Britain it would be 13 per cent.

In the smaller countries of the Community the position is very different. Arbed of Luxembourg, the biggest single producer in the Community, is the centre of a group of companies operating in Germany, France and Belgium. The Cockerill-Ougrée Corporation in Belgium, one of the biggest in Europe, produces a third of total Belgian output but is believed to control 80 per cent. of the national industry. In Holland there is a concentration consisting of the state-owned coal and steel enterprises which also controls Hoogavens, the biggest steel company. In Italy the state-controlled Finsider dominates the industry.

So far, the High Authority has not made

any use of its powers to forbid concentrations. And it is true to say that in the context of the Community-wide market there has been no need to do so. But the impending development of the general common market will change this picture. It remains to be seen how the new institutions will fare against the new giants that will inevitably spring up.

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German Steel Expansion

The expansion plans announced last week by Mannesmann and the Krupp-owned Reinhausen Stahlwerke mark a further step in the growth of German steel capacity and also in German steel interests on the American Continent. In Germany itself Mannesmann is to double the capacity of the new plant which recently began production of oil field type tubes at the rate of 10,000 tons per month. In addition the company's capital investment programme for the period ending September 10, 1959, includes two blast furnaces, two open-hearth furnaces, a plate mill, coke ovens and jointly, with Hoesch Werke, a semi-continuous wide-strip mill. The Krupp programme is designed to increase annual steel production by 600,000 tons to 2·5 million tons by 1960. Total Mannesmann output is also planned to reach 2·5 million tons by 1960, of which the output of tubes will account for 1·2 million tons, compared with 692,000 tons in 1956. (Mannesmann was discussed in detail in ENGINEERING last May 31, page 681.)

The Mannesmann programme provides for considerable expansion of the company's Canadian and Brazilian plants which will jointly provide 25 per cent. of the total tube output. The capital of Mannesmann International, the holding company for Mannesmann interests in North America, has been increased to 50 million dols. of which 25 per cent. will be offered to the Canadian public when the first dividend is earned. In addition Mannesmann International, with a 16 per cent. holding is the largest single shareholder in Algoma but has ceased further purchases of this company's shares in view of increasing Canadian criticism of the growth of foreign capital in Canadian industries.

Phoenix-Rheinrohr are also reported to have further expansion plans in America. After establishing two manufacturing plants in Canada Phoenix recently established a subsidiary in the United States. One of the functions of this subsidiary will be to handle increased purchases of scrap and coal in the United States but discussions are also reported to be in progress with the Bethlehem Steel Corporation for the conclusion of a technical exchange agreement similar to those already concluded between the August Thyssen Hütte and the Armco Steel Corporation and between Kloeckner and the Republic Steel Corporation. Phoenix have also considered the erection of a tube mill in either Venezuela or Brazil and it is possible that such a plant may be established by 1959. To some extent these overseas developments are the result of rising costs inside Germany and the need to import growing quantities of United States coal and scrap. Nevertheless the capacity of the German steel industry is planned to rise to 29 million tons by 1960, which compares with crude steel production of 23·5 million tons in 1956.

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Fewer German Banks

The Allied policy of "deconcentration" of German industry and commerce has taken its biggest reverse in the banking system. The three traditional commercial banks the Deutsche Bank, Dresdner Bank and Commerzbank were split by the Allies into 30 institutions, each with its activities confined to a single *Land*. The old Reichsbank was replaced by a system run on Federal Reserve lines with eleven *Land* banks providing the capital and board of directors for a new central bank, the Bank deutscher Länder at Frankfurt. Since the formation of the Federal Republic this system has been considerably modified. The commercial banks have gone back to the pre-war position. The thirty regional banks with names nobody knew and with their ownership in doubt were never up to the task of financing the rapidly expanding industry and trade of Western Germany. They were merged into nine institutions grouped under the three traditional commercial banks, and their ownership position regularised. The post-war move from Berlin has brought German bankers into on-the-spot contact with industry so that the dangers of over-centralisation have decreased.

At all events the Germans believe that a more closely integrated banking system can only benefit their trade and industry. The three groups of banks have been concentrated under an Act which came into force at the beginning of this year. The new Deutsche Bank has assets which make it the biggest bank on the Continent. The Dresdner Bank has also re-emerged, having taken over the property of the Hamburger Kreditbank, the Rhein-Ruhr Bank and the Rhein-Main Bank. The Commerzbank formerly had much greater interest in what is now Eastern Germany with the result that its present constituents in the West are not all at the stage of development that would make concentration advisable. Regional connections and independence of the member banks will be maintained for the time being.

While the commercial banks have been falling over themselves to get back to the old patterns, central banking has been largely unaffected. The Bank deutscher Länder under its chief, Dr. Vocke, has effectively demonstrated that a federal constitution and a strong monetary policy can go together. Nevertheless the future of the bank is undecided. The disadvantages of having nine *Land* central banks each with its own reserves will become more apparent now that the big commercial banks have re-appeared. The big problems for German banking lie ahead.

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Higher Coal Prices

Last week's announcement of higher coal prices, though it had been expected for some time, has nevertheless caused a good deal of anxiety regarding its effect on the general price level. There appears to be general agreement that in view of rising costs the National Coal Board had no alternative but to increase prices. Both the Industrial Coal Consumers' Council and the Domestic Coal Consumers' Council, to whom the reasons for the increase were explained before the announcement was made, have accepted the necessity for the increase. The price rise averages 8 per cent. and is designed to increase the revenue of the National Coal Board by £66 million in a full year. On the assumption that gas and electricity prices will rise by a similar amount, it has been estimated that the effect on the retail price index will be about half a point.

What may prove more serious in the long run, however, is the effect on industrial costs. Industry will have to meet an increased fuel bill of about £45 million, but of this total, electricity generation will account for £11 million, gas manufacture for nearly £10 million and transport for £5 million. The balance of nearly £19 million does not in fact represent a large additional burden on manufacturing industry as a whole, particularly when it is remembered that the coal content of the country's total industrial output at factory prices is estimated at 2 to 3 per cent. Much is likely to depend on the extent to which it is found necessary to raise transport charges and the influence of higher fuel prices on wage negotiations.

In most industries rising productivity should be sufficient to absorb the higher cost of fuel. The danger exists, however, that the rise in coal prices may serve as a pretext for a general raising of the price level and it is perhaps unfortunate that most of the voluntary price freezes which were entered into last year are now expiring. The need for restraint in passing on the increased fuel costs is underlined by the fact that there are signs that increasing productivity in the coal industry itself may obviate the need for further increases in coal prices for some time to come. This will not, however, be the case if general price increases lead to intensified pressure for higher wages. As regards the future of coal prices the next move may well be towards an increased differential between the price of large coals, which are in increasingly short supply, and of small, which not only account for a steadily increasing proportion of total production, but must compete with oil for steam raising and electricity generation.

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Transport Deficit

Although the British Transport Commission's Ninth Annual Report, Statement of Accounts and Statistics, published last week shows the highest deficit yet recorded it is not without hopeful indications for the future. At a Press conference the chairman of the Commission said that while 1956 had been a year of considerable difficulty and some disappointments, he hoped that in later years it might be called the turning of the tide.

The main reasons given by the Commission for the working deficit of £16·5 million in 1956 were the fall in freight sent by road and rail (largely due to the rise in the number of C licence holders) and in London Transport traffic; the freezing of fares and charges and the continuation of inflation. After allowing for capital charges, the total deficit of £57·5 million was not greatly in excess of the estimate made last October. The importance of the relative inflexibility of the machinery for the adjustment of fares and charges is shown by the fact that delays in these adjustments are estimated to have lost the Commission about £5 million of net revenue. The previous year's report pointed out that the whole of the accumulated deficit at that time could be accounted for by losses caused by these delays.

As from July 1, 1957, the Commission will have the advantage of the greater flexibility of charging permitted under the Transport Act of 1953. The Commission have stated that they will use their freedom from the restrictive effects of former legislation to develop the carriage by railway of traffic which is not now railborne but which is particularly suitable for the railway. How far they will succeed must depend on the efficiency of handling freight of all kinds. The 1956 report provides evidence of further improvement in this respect. Another encouraging sign is that recruitment of new labour excluded wastage for the first time for four years.

In the longer term, however, success must depend very largely on the progress made with the modernisation programme. Expenditure on re-equipment in 1956 totalled £90 million compared with £70 million in the previous year, and though it may be possible to criticise the rate at which orders are being placed for Diesel locomotives the plan as a whole appears to be up to schedule. The decision to place with the British Motor Corporation a £4 million contract for vacuum brake cylinders and a further contract for a new type of buffer indicates that the Commission does not intend to be delayed by lack of capacity in the industry.

Flexibility may indeed be the keynote of the Commission's policy as from the beginning of this month. The decision to raise freight charges by 10 per cent. (with a hint of higher passenger fares to come), announced on Monday, is an unfortunate opening for the new era. The higher rates may be a bigger gesture to inflation than to the new railway age.

TRACTORS IN FULL PRODUCTION

Standard's Reorganisation

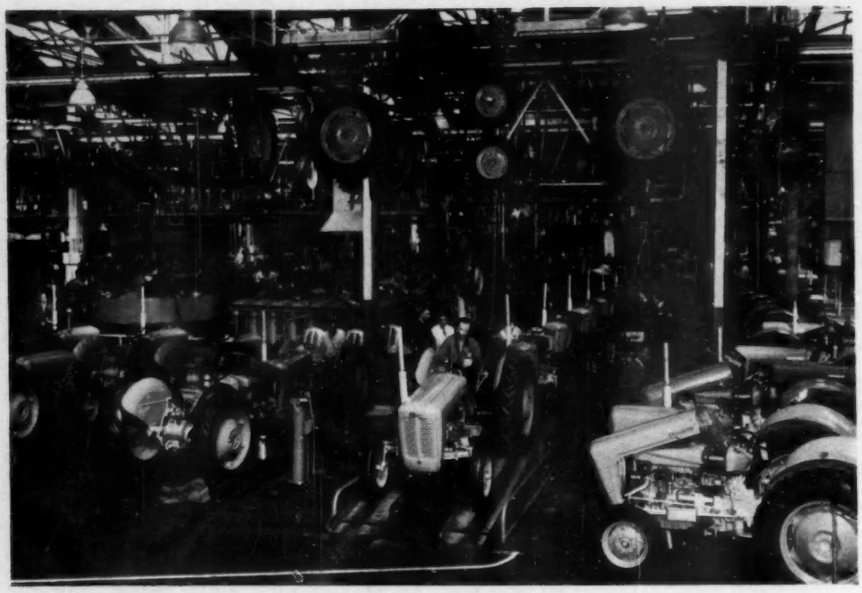
With the achievement of full production on the new Ferguson 35 tractor, and a current backlog of 16,000 orders for cars and commercial vehicles, the Standard Motor Company has emerged successfully from a very difficult period. Although over half a million of the original Ferguson tractor were made, production of which stated in August, 1946, it was decided that efficient and economical production of the new 35 model demanded complete re-equipment. Whereas tooling for the first tractor took eight months, it took 2½ years and an investment of £4½ million to prepare for production of the latest model. During that time, shrinkage of the car market made it impossible to absorb labour displaced from tractor production, and serious labour troubles resulted. Of the original machine tools, 350 were replaced by 150 modern transfer machines and over 1,000 machines were re-tooled. Practically every machine at the Banner Lane factory, and many also at Canley, were re-sited, to make what may be the largest single tractor-producing unit in the world, currently turning out 350 tractors a day. To date 40,000 of the new model have been built, and of these 60 per cent. exported.

The new plant utilises many methods not previously associated with tractor production. It makes extensive use of Heller transfer machines, with a proportion of Archdale Unimatics where some flexibility is desirable. In-line transfer, drum-type transfer, rotary index, crankshaft milling and multi-wheel grinding are all employed.

Operations on both ends of the rear axle shaft are completed on one double-ended drum-type boring machine which performs facing, turning, drilling, reaming chamfering and tapping. The 41 operations on the central housing are performed on three transfer lines, with automatic transfer between them, utilising an electro-hydraulic pick-up and turning unit which takes the work from one platen and re-positions it on another, where it is hydraulically clamped. Several transfer suites are also coupled together for cylinder blocks.

On the tractor crankshaft, all four crankpins are milled at one setting—a method pioneered in England, by Standards, which they claim gives five times the speed of any other method—using four side and face milling cutters of 20 in. diameter on movable heads. On Diesel crankshafts, multi-wheel grinders are employed, with an automatic wheel-dressing arrangement and an automatic measuring unit.

Initial assembly of the tractor takes place transversely to save floor space. The gearbox is mounted on the conveyor and, at opposite ends, engine and rear axle are offered up on moving trolleys fitted with height adjustment. The completed chassis is given a metallic bronze paint finish and then, still hot from the ovens, goes end-on on a second line where a conveyor flush with the floor carries it on two pedestals, permitting the men to move right round it. Here wheels are added, and sheet metal parts which have all been electrostatically painted in grey, and bright parts plated in zinc, which has proved more rust resistant than cadmium, are fitted in place.



The Ferguson tractor model 35 is now in full production with an output of 350 a day.

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DURHAM COLLEGES EXPANDING

Plans for More Living-In

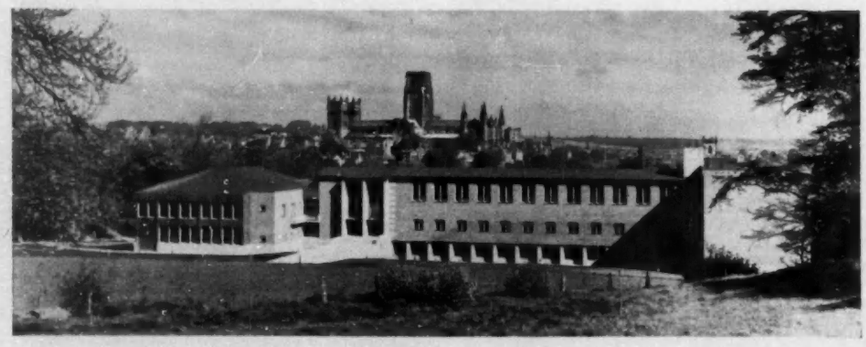
In our recent leading article " Living In " we emphasised that the proportion of engineers at the universities was increasing and that not merely were they increasing in sheer numbers, because of Government policy, but that colleges were finding that a much better class of student was now demanding an engineering education. " But," we continued, " the colleges in London and the provinces, as well as at Oxford and Cambridge, do want money to build accommodation."* It is not surprising, therefore, that among current appeals for educational purposes, is one just issued by the Durham Colleges for £250,000 to start a programme of expansion, which will finally cost about £2 million.

Discussing this appeal, at its launching in London, Sir James Duff, D.C.L., the Warden of the Durham Colleges, pointed out that the funds were being asked for on behalf of the Durham division of the University of Durham, and not for the other division—King's College, Newcastle-upon-Tyne—which had organised its own appeal five years ago; and that the money was not being sought for the upkeep of old buildings, but for the construction of new ones. The object of the appeal, he said, was to provide additional lecture halls, student residences, laboratories and equipment. It was hoped to increase the registration of science students from 400 to 1,000 and to bring the total number of students in all the faculties from 1,300 to 2,000.

Building is expected to commence this year on a new college, for the accommodation of at least 200 male students, and a starting date in 1958 has been fixed for the construction of a further block of laboratories, to house the departments of chemistry and geology, thereby releasing space for the physics and other departments The present work of the Durham Colleges in electronics is to be expanded into a separate department of applied physics. Buildings for this purpose are likely to be put in hand in 1959 and they will comprise the first part of a greatly enlarged physics department. If these aims, and the desire for a considerable expansion of existing research projects are achieved, there will still remain a need for the provision of 500 more residential places, for both men and women students, and for necessary enlargements. to the buildings of the students' unions. In this connection, it is stated in the appeal brochure that residence in college has an importance that transcends considerations of convenience. For a student to live in college, where he meets and makes friends with fellow students in all departments, and where senior and junior members can make less formal contacts than in the lecture rooms, it is pointed out, is an essential part of university education at its best.

The University of Durham, Sir James reminded his audience, had been founded in 1832 with a grant from the Dean and Chapter of the cathedral, and it had remained, like the two older universities of Oxford and Cambridge, both residential and collegiate. Durham had, in fact, the true atmosphere of a university town. During the last 30 years, the university had developed the full range of science subjects, and important research work was being carried out in nuclear physics, electronics, geophysics and radiochemistry. For some time, the university had sent a steady stream of scientists to industry in all parts of Britain. Now, it was the turn of industry and it was hoped that commercial concerns would provide the bulk of the support required for the expansion programme.

* ENGINEERING, May 10, 1957 (vol. 183), page 577.



Durham Colleges' science laboratories, erected in 1951. Land in the foreground has already been acquired and is the site of a proposed new college.

ENGINEERING FIRMS IN THE FREE TRADE AREA

4—ING. C. OLIVETTI AND C.S.p.A.

Even with present restrictions on intra-European Trade, exports of typewriters from the major manufacturing countries have been rising steadily in recent years and demand is still expanding. A lowering of trade barriers following the establishment of a Free Trade Area might well result in an even sharper rise, particularly for portable typewriters for which the demand is fairly elastic. Most leading European manufacturers have a good supply of labour, are highly capitalised and have a large and steadily rising home demand which in some cases they are finding it hard to satisfy in the face of rising demand from abroad. The overall effect of the establishment of a Free Trade Area is therefore likely to be favourable to the majority of European manufacturers.

The position is, however, complicated by the fact that many major European manufacturers are in fact subsidiaries of United States companies. International Business Machines have manufacturing subsidiaries in the United Kingdom, France, Germany, Italy, Belgium, Holland, Sweden and Switzerland. Remington Rand also manufacture in the United Kingdom, Netherlands, Germany, France and Italy, and Underwood in the United Kingdom, Germany, Italy and France. Smith-Corona have a manufacturing subsidiary in Belgium. Most of these manufacturing subsidiaries are virtually indigenous companies in that much of the stock is held by shareholders in the country concerned and most of the principal posts on the board are filled by nationals.

One of the primary objects in setting up these subsidiaries has been to avoid tariff and quota restrictions on imports from dollar countries. So far as countries forming the European Common Market are concerned, therefore, there may be a tendency for United States manufacturers to concentrate their manufacturing interests in one or two countries. This would, however, probably not apply to subsidiaries established in countries which adhere to the Free Trade Area but are not members of the Common Market, since such countries are expected to maintain their existing duties viz-a-viz countries outside the Free Trade Area. The extent to which such concentration is likely to occur will, of course, depend on a number of factors including the availability of labour and of subcontracting capacity in the various countries, the level of manufacturing costs and the extent to which these can be reduced by increasing the scale of production at a single plant, and the incidence of transport costs on the finished product.

Apart from subsidiaries of United States companies there are three major typewriter manufacturers in Europe. These are the Imperial Typewriter Company Limited, in the United Kingdom, Olympia Werke A.G. in Germany and Ing. C. Olivetti and C.S.p.A. in Italy. Of these three, Olivetti and Olympia are considerably the largest. Olivetti was founded in 1908, by Camillo Olivetti at Ivrea, near Milan. The factory at Ivrea is noted as being one of the most modern in Europe and probably more has been written about its design and the social services provided by the company than about the products turned out at the works. The Ivrea plant occupies 3,100,000 sq. ft., of which the factory floor area accounts for 853,000 sq. ft., and employs over 6,000 which compares with only 125 workpeople engaged in 1915. The company now have five factories in Italy, and three manufacturing subsidiaries abroad—in Spain (Barcelona), Argentina (Buenos Aires) and the United Kingdom (Glasgow).

Olivetti's total production of typewriters in Italy has risen from 2,000 in 1922 to about 350,000 per annum at the present time. While typewriters are still the company's main product, however, they also make other types of office machinery. After the war there was a strong move towards diversification, and besides four types of typewriter (one of which is electric and another portable) the company produce eight types of calculating machine, three kinds of teleprinter, a tape recorder and office furniture and filing systems. Since the war, Olivetti's expansion in calculating machinery has been particularly marked, and research is being pursued at Ivrea in the important field of computer development.

A world-wide selling organisation helps to account for the company's high export ratio (about 70 per cent. of total production). The company has its own sales outlets in Belgium, France, Austria, Mexico, South Africa, Australia, United States, Colombia, Brazil, West Germany and Canada. In addition a large network of agencies extends the company's sales activities to most parts of the world.

SELF-CONTAINED

Olivetti lay particular stress on three factors: modernised equipment coupled with good maintenance, a good supply of skilled labour and a high degree of business organisation. Their aim is to make themselves completely self-contained—in marked contrast to the majority of United States subsidiaries who tend to rely to a considerable extent on sub-contractors for the supply of components. All machine tools used by Olivetti are, for instance, manufactured by the associated company Officina Meccanica Olivetti (O.M.O.), founded in 1926 for the production of presses, lathes, milling, grinding and planing machines. The company has its own foundry which started production in 1922. Olivetti even have their own printing works which produce publicity material as well as complicated blanks used during the production process, financial statements and other forms used by the administrative offices. A large independent plant has also been established for producing light alloys and for pressure-moulding the machine casing.

Inspection is very tight and the Olivetti materials-control section supervises every step in the procurement and use of materials. Special instruments have been developed by the company in the selection of materials and components. As regards skilled labour Olivetti draw to a large extent on their own apprentice school attached to the Ivrea works. They also insist that their service staff should be fully qualified, and many of the service engineers are trained in the apprentice school.

The company have also built up a high reputation for service, and maintain both in Italy and abroad a customer technical assistance service staffed by 1,200 technicians and mechanics. Olivetti claim that of their 850,000 machines of every type in use in Italy, 350,000 have been serviced by this organisation. The company is also active in the field of market research. A good example of this last is to be found in a paper read to the International Conference on Marketing held under the auspices of O.E.E.C. in May, 1956. Mr. U. Galassi, general sales manager of Olivetti, told the conference that by exploring new avenues of distribution, sales of the portable "Lettera 22" typewriter in Italy had increased fourfold during a five year period. Sales were further encouraged by free typing lessons given in mobile schools and by keeping the price of the "Lettera 22" down to a bare minimum of 38,800 lire (about £22).

Hitherto, Olivetti have been markedly successful in the field of intra-European trade. There are manufacturing subsidiaries of three large American companies in Italy and one or two smaller producers, but it is probably true to say that Olivetti account for between 60 and 70 per cent. of Italian exports of typewriters. Table I shows exports of typewriters from the principal European countries and in each case the exports to other European countries. It will be seen that Italy is the third most important country so far as total exports are concerned, her exports being exceeded only by those of Germany and the United Kingdom. As a supplier of European countries, however, Italy is second only to Western Germany. This is particularly impressive when it is remembered that the bulk of the United Kingdom demand for Olivetti typewriters is satisfied by the Glasgow factory. The largest individual market for Italian typewriters is Western Germany in spite of strong competition from Olympia Werke and the American subsidiaries in that country. France is also a big customer despite the high import duty (25 per cent. on portables and 22 per cent. on other typewriters) and again competition from American subsidiaries. Italy—and Olivetti—would appear to be well placed for further expansion in European trade in view of their success in surmounting present tariff barriers.

If European import duties are removed Italy should benefit from relatively low wage rates and greater availability of labour compared with her European competitors. Average hourly wage rates in 1955 were 26*d.* per hour compared with 34·5*d.* per hour in France, 36·1*d.* in Germany, 48·0*d.* in the United Kingdom and 65*d.* in Sweden. Unemployment rates for the same year were: Italy 9·8 per cent., Germany 5·1 per cent., Sweden 2·5 per cent., and United Kingdom 1·2 per cent. While the largest pool of unemployment in Italy is in the south, Olivetti are fully aware of this and already have a factory at Pozzuoli, near Naples, for the production of calculating machines. If necessary, they could draw still further on the available

TABLE I.—TYPEWRITER EXPORTS FROM PRINCIPAL EUROPEAN COUNTRIES (£1,000).

	W. Germany		Netherlands		France		Sweden		Italy		United Kingdom	
	1954	1955	1954	1955	1954	1955	1954	1955	1954	1955	1954	1955
To:												
Austria	415	561	8	23	—	—	9	3	64	92	—	—
Netherlands	424	525	/	/	}	—	28	17	218	192	55	73
Belgium	236	244	} 22	48	25	—	} 27	15	112	—	{19	42
Luxembourg	19	21									—	—
Sweden	179	213	6	24	22	—	/	/	15	83	26	4
Switzerland	182	224	8	29	—	—	5	4	46	30	—	11
France	82	91	18	39	/	/	47	59	314	408	18	17
Denmark	209	196	43	21	—	—	20	18	73	—	20	15
Finland	10	103	1	11	3[1]	—	—	12	29	—	14	35
Greece	12	14	4	2	—	—	—	4	2	—	4	16
Norway	62	58	17	19	—	—	34	27	18	—	165	145
Italy	197	203	10	23	—	—	53	55	/	/	213	169
W. Germany	/	/	19	9	—	—	12	24	167	295	39	29
United Kingdom	370	684	183	386	6[2]	—	21	25	126	150	/	/
Total—W. European Countries	2,397	3,137	339	634	56[2]	—	256	263	1,184	1,250[2]	573	556
Total—all Countries	4,390	6,010	1,042	2,095	522	—	780	812	2,440	3,190	3,004	3,630
Proportion to W. European Countries (per cent.)	54·2	52·0	32·5	30·4	15·0[3]	—	35·5	32·3	48·5	45·0[3]	19·2	15·3

[1] Under 6·5 kg. only. [2] Incomplete. [3] Approximate.

labour in southern Italy though the difficulty in the short run would be to find an adequate pool of skill. Remington Rand already have a successful typewriter production plant at Naples and these two office machinery factories point the way for further expansion in the economically backward parts of Italy.

BUYER AND COMPETITOR

While Germany is at present one of Olivetti's biggest markets, it is also the country offering perhaps the strongest competition in the shape of Olympia Werke A.G. of Wilhelmshaven. Founded a little before Olivetti, in 1903, this company now claims to account for almost one-sixth of the turnover of the German business machine industry as a whole; the output of typewriters in 1956 was expected to reach 500,000 units. As producers of typewriters, therefore, Olympia are larger than Olivetti and their factory floor area of 940,000 sq. ft. exceeds that of Olivetti's Ivrea plant. Moreover, personnel employed at Wilhelmshaven in 1956 is believed to have exceeded 10,000, while employment at Olivetti's Italian plants probably does not much exceed 8,000. On the other hand, Olympia have only one factory in Germany and no manufacturing subsidiaries abroad, though their sales organisation is world wide. They have recently started production of adding machines, but their activities outside the typewriter field are relatively less important than those of Olivetti. Their capital of £2,140,000 compares with £3,100,000 in the case of the Italian company.

While the number of typewriters produced by Olympia is in excess of the output of Olivetti's Italian factories, the two protagonists differ in one important respect. Earlier in the article it was noted how market research had improved sales of the Olivetti "Lettera 22" typewriter in Italy, but in fact this is the only portable the company produces. Sales of Olivetti portables are around 10,000 units a year, or probably about 3 per cent. of their total sales of typewriters. Olympia, on the other hand, are virtually specialists in this field and produce some 22 portables to each standard machine. In 1955, of a total turnover in typewriters and adding machines of DM91 million (£7¾ million), turnover in portables accounted for DM72 million (£6·1 million). Olympia claim they account for about half the total German production of portable typewriters and, in 1955, 60 per cent. of their output of these machines was exported. There are some grounds for believing that under Free Trade sales of portable typewriters may expand more rapidly than those of standard machines. Olivetti have already shown how sales can be increased by distribution research and low prices. Standard typewriters are necessary adjuncts to expanding industry but portable typewriters find a large outlet as consumer goods and, if a lowering of trade barriers results in further reductions in prices, the demand may well expand faster than that from industry, since the consumer is more price conscious. To this extent, then, Olympia would appear to be well placed for European free trade.

In other respects the Olivetti organisation is probably better equipped to meet a growing demand. Olympia are faced with the problem of labour shortages in Germany, while wage costs are rising and raw materials are in short supply. Moreover, they have not diversified production to anything like the same extent as Olivetti. While Olympia reported in 1956 that sales of their adding machines were increasing and "further developments are likely" Olivetti are already well diversified and could probably compensate for a decline in sales of any one product by expansion in other fields.

The German typewriter industry on the whole is, however, well placed to meet Italian competition. They are firmly entrenched in the European market; their exports to other European countries are larger than those of any of their competitors and they are able to meet foreign competition in the German home market without heavy import duties. The German duty on typewriters is at present between 8 and 12 per cent. according to type. By contrast the French duties range from 22 per cent. to 25 per cent., the Italian duty is 20 per cent., and the United Kingdom duty ranges up to 20 per cent. of the value.

BRITISH MAKERS

In the United Kingdom, American subsidiaries account for a high proportion of the total output of typewriters. I.B.M., Remington Rand and Underwood all have manufacturing subsidiaries here while British Olivetti Limited manufacture Olivetti typewriters at Glasgow. These four companies probably account for about 70 per cent. of British typewriter output. In view of the existence of associated companies on the Continent they are concerned chiefly with supplying the home and Commonwealth markets. This does much to explain the relative unimportance of British made typewriters in intra-European trade. The three major fully British companies are, of course, in a different position. Imperial Typewriters, Limited, the biggest of the three, are finding that despite keener competition both at home and abroad sales of standard typewriters are being maintained. In the important field of portables, however, sales were affected in the home market last year both by the hire purchase restrictions and "by large numbers of machines being imported from the Continent." A further reduction in prices following a reduction of import duties would probably more than counterbalance any future hire purchase relaxations.

In this connection Imperial have decided to diversify production at their Hull factory, hitherto concerned with portables, to intensify advertising and try to open up new markets, and have claimed a measure of success in this policy. They must, however, view with some anxiety the increased competition which must result in the home market from any reduction in the duty on portables, particularly in view of rising materials and wage costs in this country, which recently necessitated raising the price of standard machines by about 10 per cent. and of portables by 5 per cent. As regards standard machines Imperial have benefited to some extent in the past from the tendency of Government Departments and public authorities to prefer fully British machines, and this may well continue provided that no very great disparity in price develops. At present the demand for British typewriters continues to exceed supply and this applies not only to Imperial but also to the Oliver Typewriter Manufacturing Company, Limited, and Byron Business Machines, Limited, who completed the replanning of their Nottingham factory in 1955 and are rapidly expanding production of portables.

As in Germany, further expansion of output of British typewriters may well be limited by continuing shortage of labour; taking all factors into account the United Kingdom industry may well stand to gain less from European Free Trade than their Continental competitors. Table II shows how sales of Continental typewriters in the United Kingdom have grown over the last few years.

TABLE II.—*United Kingdom: Trade in Typewriters with Western European Countries*[1] 1953–55 (£1,000).

	1953	1954	1955
Exports	333·0	573·7	555·3
Imports	296·4[2]	826·8	1,496·8[2]
Exports (+) or Imports (−) balance	+36·6	−253·1	−941·5
Proportion of total imports from W. European countries	80·0	93·2	97·4
Proportion of total exports to W. European countries	14·9	19·2	15·3

[1] W. Germany, France, Italy, Belgium, Netherlands, Luxembourg, Finland, Sweden, Norway, Denmark, Switzerland, Greece.
[2] Including electric typewriters.

To sum up, the range of import duties at present imposed on typewriters in European countries is considerably narrower than in the case of many other engineering products. In the case of standard machines it is probably true to say that price differences resulting from these duties are less important than design, appearance and individual preference in determining the consumers' choice. To this extent the advent of the Free Trade Area may not result in any great change in the pattern of trade except in so far as it may encourage concentration of production by American subsidiaries in a smaller number of plants. In the case of portables on the other hand, price changes resulting from removal of import duties may have more far-reaching effects, and those companies such as Olympia Werke who are already producing portables on a large scale are likely to be well placed to achieve further expansion of output. Nevertheless, the Italian challenge is formidable. There are reserves of technical as well as unskilled manpower in Italy, and United States dollars have been used (not without a background glance at the donors) to establish business efficiency and management courses with considerable success. These are all significant ingredients for the Italian offering under the Free Trade Area so far as office equipment is concerned.

WELDING IN ENGINEERING PRODUCTION

The three main objects of the British Commonwealth Welding Conference, organised by the Institute of Welding and held in London and Saltburn-by-the-Sea from June 17 to 29, were to exchange information on the present technical position of the welding processes and their main applications within the Commonwealth; to consider means of improving the flow of technical information concerning welding among the countries of the Commonwealth; and to emphasise the importance of the contribution which welding can make increasingly to the development of modern engineering production.

Well over fifty papers were presented at the conference and, of some of these, we give brief outlines below.

WELDED BOILER DRUMS

In the course of their paper, "Welding in Boilers and Power-Station Plant," Mr. T. Carlile and Dr. H. Harris, of Babcock and Wilcox, Limited, said that boiler drums had now become so large that they could be made only by welding, because the largest hollow forgings would no longer meet the demands of the designer. The largest boiler drum now being made in Great Britain was 66 ft. 6 in. long, by 6 ft. inside diameter, and was fabricated from 5¼ in. thick plates having a minimum tensile strength of 38 tons per sq. in. The safety valve pressure was 2,750 lb. per sq. in., and the hydraulic test pressure, 4,125 lb. per sq. in. The weight before tube-hole drilling would exceed 110 tons and the weight of a completed fusion-welded drum, as dispatched, was 90 tons.

WELDING ON THE RAILWAY TRACK

Several papers dealt with work on the railway track, the first of these, "Hardening of Rail Ends," being by Mr. G. K. Colligan, welding engineer to New Zealand Industrial Gases, Limited, Lower Hutt, New Zealand. He described a method adopted on the New Zealand Railways for flame-hardening rail ends to 350 to 400 Brinel hardness, over a distance of 1½ in. to 2 in. The self-quench method was used, the body of the rail being the quenching medium, and the time taken to harden one rail end was 10 seconds. A multi-nozzle flame head was mounted on the rail end, the oxygen manifold pressure adjusted to 20 lb. per sq. in., and the

acetylene manifold pressure to 12 lb. per sq. in. The flame head was lit with an air-acetylene flame and, after 10 seconds by stop watch, the flame was turned off and the equipment moved to the next rail end.

Measurements of wear had been taken in 1954, soon after treated rails had been put into service, and again in 1956 after a period of 21 months. During that time about 6½ million tons of traffic had passed over the line and the measured profiles showed that there had been about 3½ times more wear on the unhardened than on the hardened rails.

Another paper on rails was by Mr. R. S. Loubser, of the National Mechanical Engineering Research Institute, Pretoria, South Africa. It was entitled "Fatigue Strength of Thermit Welded Rails" and the author stated that great importance was attached to the fatigue strength of rails, and particularly to any reduction in the fatigue strength due to incipient weaknesses such as might occur at joints and welds. Fatigue tests had been carried out on thermit-welded and as-rolled rail specimens and it had been found that the fatigue limit in pulsating bending was 44 per cent. lower for the welded rail. Superimposed constant longitudinal stress, as would be caused by temperature variations in the track, influenced the fatigue strength of a welded rail to a marked extent. The reduction in fatigue strength of the welded rail was due to adverse influences inherent in welded materials, combined with stress concentrations at changes of section. Both aspects should be studied individually if a systematic improvement in the fatigue strength of welded components were to be achieved.

LONG RAILS

A further paper giving the South African point of view was entitled "The Use of Welding for Track Maintenance"; it was by Mr. E. A. Whitelock, welding engineer to the South African Railways. He stated that the South African Railways now had three flash-butt welding depots in operation for the production of long rails, and a length of 120 ft. had been adopted as the standard rail. Where greater lengths were required, 120 ft. flash-butt-welded rails were supplied on the site and there they were thermit-welded to the requisite lengths. When the occupation of the track could be arranged, the work was done *in situ*, otherwise the 120 ft. lengths were aligned and welded alongside the track and conveyed to the point of insertion on special rail transporters. In this manner, rails 960 ft. long in the open and over 3,000 ft. long in tunnels, had been produced. Either long or continuous rails had also been laid in transhipping sheds, asphalted areas, marshalling yards, crossing loops, and elsewhere.

Battered rail ends were built up when the average batter, namely the maximum clearance between the rail crown and an 18 in. straight edge placed with an end just across the gap, measured 0·030 in. Crossings were not allowed to develop more than $\frac{1}{8}$ in. wear before being built up on the track. The worn point rail must be built up to uniform and straight ramp backwards from the point, and this ramp must be backed by a gradual reverse ramp to the level of the splice rail. A competent crossing welder could complete from 12 to 16 crossings a week.

Speaking on the subject of the "Welding of Rail Joints" Mr. K. C. Sood said that up till the end of March, 1956, about 315 miles of track on the Indian Railways had been welded by the thermit process and that, of about 62,000 welded joints only 77 had failed in service. Rails were still being welded in panels not exceeding 210 ft., namely five rail lengths.

The Indian Railways proposed to carry out trials with ¼-mile welded rails both with and without special switch joints, and both on single and double-line tracks. After they had gained experience under their conditions of sleeper spacing, depth of ballast, track maintenance, and so on, a decision would be taken on where these special joints were necessary and how the track should be anchored.

A review of the special characteristics of aluminium and its alloys which made these materials highly suitable for chemical plant applications, was contained in a paper by Mr. W. A. Gardner, of Aluminium Laboratories Limited, and Mr. T. J. Peake, of Northern Aluminium Company, Limited, Banbury. In their paper, entitled "Welding of Aluminium in the Chemical and Allied Industries," the authors stated that modern welding processes must be adopted and the use of inert gas shielded-arc methods, justified. Apart from the various fabrications in pure aluminium, for components subject to pressure, the stronger non-heat-treatable alloys were gaining favour. Where intricate shapes required the use of castings, the alloys LM5 (Aluminium-5 per cent. magnesium-0·5 per cent. manganese) and LM6 (Aluminium-11·5 per cent. silicon) would be found to cover most requirements. Wrought aluminium alloys showed not only increases in tensile strength and yield strength as the temperature decreased to − 254 deg. C., but there were also increases in elongation.

NICKEL ALLOYS

"Developments in the Welding of Nickel and High-Nickel Alloys for the Chemical Industry" were dealt with by Mr. J. Hinde, of the Development and Research Department of the Mond Nickel Company, Limited. He stated that at temperatures exceeding 400 deg. C. nickel had a great affinity for sulphur. Heating the metal in the presence of sulphur might give rise to the formation of a brittle intergranular compound which was capable of causing cracking. In the presence of grease, paint or other contaminants containing sulphur, the heat of welding might bring about sulphur attack in the weld area. Low-melting-point alloys and zinc-base alloy tools were often used during the forming of pipe and sheet, and any traces of such materials adhering to the surface of nickel alloys must be removed, since they could cause severe cracking of the weld deposit or of the heat-affected zone. For similar reasons lead and lead compounds should not be allowed to contaminate the surface.

Chemical plant often required the use of one or other of the high-nickel alloys to meet specific corrosive conditions, but the thickness of the material necessary for strength could make the plant very costly. Fortunately, in such circumstances, it was often possible to employ clad steels, to use an applied lining, or to apply overlays deposited by a welding technique.

Mention should also be made of the recent development of electro-deposited nickel-on-steel sheets. This deposit was normally only about 0·010 in. thick, and it was extremely difficult to maintain the continuity of the coating at a weld, but for certain applications involving only mildly corrosive conditions, such as the handling of sugar solutions, such material had proved quite useful.

A third paper, "Selected Welding Problems in the Heavy Chemical Industry," was by Mr. M. E. Pool and Dr. P. T. Moore, of the Billingham Division of Imperial Chemical Industries, Limited. It dealt with the inspection and control of flash-butt-welded pipework and the use of backing rings for manual pipe welding. The backing rings employed were of non-metallic material, of sufficient strength not to break up during fitting or welding, but pliable enough to be broken up for removal when welding was completed. Sand bonded as for foundry cores, had proved to be a suitable substance. The method was promising.

Other problems discussed related to "weld-decay" and other examples of the loss of corrosion resistance in austenitic steels and the remedies adopted, and a final section dealt with requirements for low-temperature service.

The authors' experience indicated that mild steel, with appropriate safeguards, was a suitable material for use at temperatures down to −50 deg. C. For operating temperatures below −50 deg. C., there was a range of materials which had adequate notch-impact strength by the accepted standards. Aluminium provided satisfactory impact-strength, at least down to −100 deg. C., although its comparatively low tensile strength frequently limited its use for pressure equipment. Austenitic steel was the preferred material for all applications below −50 deg. C., where aluminium was unsuitable.

The requirements for sub-zero temperature service were further discussed in a paper entitled "Low-Temperature Properties of Some Welded Austenitic Steels," by Mr. F. A. Ball and Dr. K. Balajiva, of the research and development department of the Mond Nickel Company, Limited, Birmingham. The authors stated that the tensile and impact properties of metal-arc welded joints, using matching electrodes, had been determined for four austenitic chromium-nickel steels at temperatures between 20 deg. and −196 deg. C., and compared with those of the corresponding wrought steels. The variation of Charpy V-notch impact strength across the welded joints had also been examined. The main deficiency in the mechanical properties of the welded joints at low temperatures, in comparison with those of the wrought steels, was in ductility and impact resistance. There was, however, a possibility of improving the impact-properties of the welded joints in the austenitic steels by using nickel-base alloy welding electrodes. In particular the 80 : 20 nickel-chromium and the 76 : 15 : 9 nickel-chromium-iron types could be expected to give sound joints, retaining good impact strength at temperatures down to −196 deg. C.

WELDING OF STAINLESS STEELS

Many problems connected with the welding of heat and corrosion-resisting austenitic steels were discussed in several other papers.

The first, "Welding Austenitic Steels for Gas-Turbine Rotors," by Mr. R. R. Roberts, of the research laboratory, British Thomson-Houston Company, Limited, Rugby, described the construction of large rotors for industrial gas-turbines by the welding together of relatively small forgings made from steels of the austenitic creep-resisting type. The rotor consisted of five portions: two shaft ends and three body portions which were welded together by the manual metal-core process. The partially-machined forgings were assembled, and the shaft-end welds were completed without pre-heat. At this stage the rotor was placed in a gas-fired preheating box. While being continuously rotated the body of the rotor was slowly raised to a temperature of 650 deg. C. Welding was then carried out using extension pieces for electrodes, so that the welder's hand was held about 18 to 30 in. from the point of welding. The rotor was cooled slowly to below 150 deg. C., so that the slag could be removed and the weld adequately cleaned. This cycle of operations was repeated for each run of weld. On the completion of welding, the rotor was allowed to remain at 650 deg. C. for 72 hours and finally it was allowed to cool slowly to room temperature. The welds were machined for examination, and, apart from a few small slag traps, they were found to be satisfactory. Radiographic examination was also carried out on all the welds. Two gas turbines with rotors of the type described were now operating in Nairobi.

The causes and effects of hot-cracking, martensitic cracking and sigma-phase embrittlement in stainless-steel welds were described in a paper by Mr. M. C. T. Bystram, of Murex Welding Processes Limited, Waltham Cross, Hertfordshire, on the "Application and Performance of Ferrite-Controlled Stainless-Steel Electrodes." (The sigma phase in high chromium-nickel steels is an intermetallic chromium-iron compound which causes embrittlement and a reduction of ductility.) The author discussed the metallurgical characteristics of austenitic chromium-metal welds in service at temperatures of between − 200 deg. and + 800 deg. C. and stated that the best compromise of properties might be obtained by the use of more closely-balanced alloying in weld deposits of austenitic stainless-steel electrodes having a controlled ferrite content.

TESTS ON CONCRETE

Conversazione at the Institution of Civil Engineers

Rolling motion problems under investigation at the Engineering Laboratory, Cambridge, were demonstrated by apparatus shown at this year's conversazione of the Institution of Civil Engineers, which took place at the Institution building in London on June 19. The equipment demonstrated how a ball rolling round a circular path applies a continuous twisting action to the surface on which it rolls. The Laboratory's investigation has shown that the elastic distortion of the track and the ball under the action of this twist results in the ball following a spiral path of gradually increasing radius. This phenomenon is of significance in a number of rolling problems.

Almost without exception, all the thirty or so models and apparatus on view had a direct, and pertinent, civil-engineering interest. Among the exhibits shown by Dr. A. R. Collins, Technical Director, Cement and Concrete Association, was equipment for utilising the gamma rays arising from cobalt 60 and iridium 192, and techniques similar to those employed in the gamma radiography of metals, for investigating various aspects of reinforced concrete, such as the location of reinforcements and the effectiveness of grouting. It was pointed out that the requirements for gamma radiography of concrete were cheap, simple and manoeuvrable. The process was eminently suitable for non-destructive testing, especially on a site. Four models were displayed by Dr. F. M. Lea, Director, Building Research Station, showing the strength and stability of multi-storey buildings and the parts played by elasticity, plasticity and composite action in deciding the ultimate strength of the frameworks. An indication was given by these models of how the sideways swaying of tall buildings in a wind, coupled with the tremendous vertical loads involved, could give rise to the phenomenon of instability and a lowering of the collapse load. The beneficial effects of stiffening floors and walls were shown.

Among the static models displayed may be mentioned the radio telescope for Manchester University which is nearing completion at Jodrell Bank, shown by Mr. K. Paterson; the nuclear power station being erected at Berkeley, Gloucestershire, shown by W. S. Atkins and Partners; developments at Gatwick Airport, shown by Frederick S. Snow and Partners; and the new footbridge in St. James's Park, shown by the Ministry of Works.

A SEAWEED SERVICE

The report of the Institute of Seaweed Research indicates that the difficulties which threatened to close down the Institute towards the end of the 1955/56 academic year have been surmounted. The objectives have been modified and are now less ambitious. As a result of the recommendations made by the Advisory Council on Scientific Policy, the Institute's original mandate —" to determine whether the possibility existed of creating a stable Scottish seaweed industry which could compete with those of other countries and at the same time provide a considerable part-time crofter industry in the Highlands and Islands "—has been abandoned. From July last year, the Institute's responsibilities have been limited to the promotion and assistance of algal research.

The report states that the Institute's new services are now properly understood and increasingly utilised. During the year under review some 150 inquiries were received, 58 of them emanating from abroad. This is certainly evidence that a live interest continues to exist in the potential use of seaweed. Of the inquiries handled by the Institute, 22 were concerned with harvesting and processing problems, 23 with the technique of seaweed meal production and 10 with the manufacture of seaweed extracts. The Institute are able to render practical assistance and several of their tasks last year involved visits to assess the problem on site. One such visit was paid to a large estate in the North of Scotland to assess its seaweed resources and to advise on their possible utilisation. Another concerned estimating the seaweed resources of the Pairc Division of the Island of Lewis and to indicate both methods and costs of harvesting the 8,000 tons growing on accessible shores. The possibility of finding new markets for the algal chemicals had been pursued and, as a result, the British Steel Castings Research Association has agreed to undertake research on the applications of alginates to foundry practice.

The Institute's review of extra mural research (no work of a fundamental nature is carried out out in their laboratories) shows that a great many uses have been developed, some of which may be economic. The use of seaweed as cattle and sheep food and as a fertiliser are well known; other uses, in medicine and biochemistry, are the subject of research and development. On the whole, therefore, the report suggests that the Institute have by no means failed in their task. It is difficult to understand why its resources for fundamental research and the promotion of a seaweed industry in Scotland could not have been financed from charges for its services to industry.

* * *

FUTURE OF COPPER

The reduction by Rhodesian Selection Trust of its selling price for copper to £230 a ton has given rise to a good deal of speculation regarding the future of copper prices, if only because it was generally believed that the two Rhodesian producers were making every effort to prevent the price falling below £240. They are believed to have bought between 8,000 and 10,000 tons in London in an attempt to support the price level and this was followed by an agreement (not yet effective pending the co-operation of the principal consumers) to adopt a common pricing policy. Finally came the decision of Rhodesian Selection Trust to restrict output from their two largest mines by 10 per cent.

The fall in copper prices over the past year has been much more severe than that in other metal prices, but this was due to the exceptionally high price, £437 a ton, reached in March, 1956, as a result of a number of special factors including serious production losses due to strikes. A minimum price level of around £240 a ton has appeared reasonable because this was the level prevailing three to four years ago and it was agreed that the price would settle somewhat above this level in view of the general price inflation which has taken place since then. Moreover the Rhodesian producers need considerable profits to finance their expansion schemes, which even if not essential at the moment will be required once the expansion in consumption is resumed.

On the other hand a price of £240 a ton is about five times the average level prevailing immediately before the war and the average break-even point for the Rhodesian producer is about £120 a ton. A high price was required immediately after the war to cover the costs of marginal producers but low cost capacity has been expanded by about 400,000 tons per annum in the last three years and a further 500,000 tons per annum will probably be added over the next five years. There are therefore grounds for believing that a period of low copper prices may prove to be in the best long-term interests of producers both in order to encourage consumption and to eliminate some high cost production. In any case, in the absence of a marked revival in consumption, maintenance of even the present price level is likely to require much more drastic limitations of output than has been attempted so far.

* * *

LAMINATED TIMBER CONSTRUCTION

As a step in assessing the potentialities of laminated timber construction the Timber Development Association Limited, last week published some of the findings of an interim report prepared by Mr. E. Levin, A.R.I.B.A., chief architect of the T.D.A. In March last year the O.E.E.C. published a comprehensive report, *Laminated Timber*, based on the findings of a team which visited timber laminating plants in the United States. The T.D.A. felt, however, that European practice would provide a better guide to possibilities in this country, in view of the greater similarity of costs of raw material and labour in Europe and the United Kingdom. Mr. Levin therefore visited Switzerland, Belgium, Germany and France and it is hoped that investigations will be extended this year to Sweden, Norway and Finland.

Of the countries visited, developments were perhaps most advanced in Switzerland and Holland, but there are important differences in the two countries. In the former the production of laminated timbers is undertaken by a wide range of wood working firms, carpenters and sawmillers, whereas in the latter it is a separate industry with a considerable export trade. France is relatively backward in this field, and although Germany was the first country to develop glued lamination in the inter-war years, present-day activity is disappointing.

Regarding possible developments in this country, Mr. Levin sees a future in the production of straight beams and long-radius curves, which permit thicker laminates and fewer glue lines. From studies in Holland and Belgium he estimates that for spans over 35 ft., laminated timber construction is competitive with reinforced concrete and steel, though in these two countries prestressed concrete is the most serious competitor. For very large spans over 100 ft. it is claimed that laminated timber can be supplied for as little as half the price of reinforced concrete.

The Hampshire County Council recently placed a contract for 300 glued laminated beams for use in the construction of schools and the renewed interest in this material, which has, of course, been employed in Europe for the past 50 years, may lead to an expanding use in this country.

* * *

ZINC AND LEAD PRICES

Zinc and lead prices have fallen this year by about 30 per cent. compared with the peak levels reached during the Suez crisis and by 20 per cent. compared with the levels of a year ago. As with copper, (Weekly Survey in the June 14 issue), this has been due in part to the cessation of the rapid increase in world consumption which prevailed up to 1955 and the failure of producers to check production. In addition, there is a good deal of anxiety regarding the future of purchases for the United States Government stockpile and the revision of the barter programme of the United States Agriculture Department.

In the case of zinc, 1956 saw a fall in world consumption of about 100,000 tons to 2·2 million tons, while mine output rose by 150,000 tons (zinc content) to 2·5 million tons. The fall in consumption took place mainly in the United States and the United Kingdom, which together account for about half the total world consumption, and was primarily due to the recession in the motor industries in those two countries. A reasonable balance between production and

consumption was maintained during 1956 because the United States stockpile took 157,000 short tons. In spite of statements by the Director of Defence Mobilisation that purchases of lead and zinc for the stockpile would continue for a while at least, in recent months fears have become acute that this support is likely to be removed and these have drawn attention to the underlying weakness of the position. Two main producers in the United States have announced cuts in output but if, in fact, stockpile purchases were to be seriously reduced, considerably more drastic action would be required.

It is rather surprising that lead prices should have fallen to about the same extent as those of zinc, since lead is less dependent on United States stockpiling and is also less affected by the rate of new car production in view of the demand for replacement batteries. Moreover, about one-third of United Kingdom lead consumption goes into cables of which output has been increasing. World production of lead has, however, been expanding more rapidly than consumption.

In spite of heavy import duties the United States is a large importer of lead and zinc, both in the form of metal and of concentrates for smelting by American Custom Smelters. The negotiations which have been in progress for the last two years to establish a long-range programme for the United States mineral industry are therefore not the least of the factors tending to unsettle the market for lead and zinc. While United States producers have been pressing for an increase in the tariff designed to maintain the domestic price of lead at the equivalent of £144 and that of zinc at £120 a ton it has been calculated that United States consumers are already spending nearly 18 million dols. in protecting the domestic lead and zinc mining industries. There is little sign of an early solution of this problem and in view of the other factors mentioned above there would appear to be little prospect of an early recovery in lead and zinc prices.

* * *

WIRE ROPE CUTTERS

A portable wire rope cutter is now available from Tulloch Construction Company, Limited, 70 Brighton-road, Sutton, Surrey, and is shown in the accompanying illustration. It is made in three sizes, with maximum cutting capacities of $\frac{5}{8}$ in. diameter, 1 in. and $1\frac{1}{2}$ in. respectively.

It is very simple to operate, and the only additional tool required is the heavy hammer. Spare blades are available for all models and it is claimed that the rope is cut cleanly without flattening or distortion. Before cutting, the rope should be served with stout twine on each side of the cut. Although these units are normally portable, bolting-down holes are provided in the base for use if desired.

Wire ropes up to $1\frac{1}{2}$ in. in diameter can be cleanly cut by a hammer blow.

* * *

BUTANOL PRODUCTION AT BILLINGHAM

A second large-scale carbonylation has been placed in commission by Imperial Chemical Industries, Limited, at their Billingham Works, County Durham. This plant will be used for the production of butanols, a range of important raw materials employed by many industries. The largest consumers are paint and lacquer manufacturers, who use butanols, either as such or in the form of esters, mainly as solvents or plasticisers. Other users include manufacturers of pharmaceuticals, printing inks, and hydraulic-brake fluids. The raw material for the new carbonylation plant, propylene, will come by pipeline under the River Tees from the large oil-cracking installations operated by the Billingham Division at the firm's Wilton Works, in North Yorkshire. With this second carbonylation plant in full production, the I.C.I. output of butanols is increased sevenfold, and the need for imports from the United States, Germany and Sweden will be eliminated.

* * *

POLYTHENE TUBING FOR COLD-WATER SERVICES

Among the advantages of polythene tubing for cold-water services are that the material does not contaminate drinking water, is flexible and easy to joint and manipulate, and that the installed cost is usually less, per foot run, than that of metal tube. Moreover, the specific gravity of polythene is 0·93, and tubing of this material is much lighter in weight than steel tubing. This makes for easy handling and reduces transport and handling costs. Other advantages are that, as the material is elastic, it will not burst when the contents of a tube freeze, and that long lengths are available, namely coils up to 500 ft. long, thus saving joints. Polythene is not corroded by water or soil and therefore needs no protective coating, even when buried. In corrosive situations, however, metal joints in the pipes must be protected by wrapping with polythene-based adhesive tape. Polythene tubing has a few limitations. For example, it is not suitable for use with hot-water systems as it softens when heated, and melts at 111 deg. C. (232 deg. F.). Furthermore, polythene cold-water tubing must be supported at close intervals or, preferably, continuously.

An illustrated guide to the installation of polythene tubing for cold-water services, containing illustrated data of interest to all who are contemplating using this material, has been issued as "Ministry of Works Technical Notes No. 2." It is published, price 6*d.* net, by H.M. Stationery Office, York House, Kingsway, London, W.C.2.

* * *

BORE MEASURING

A set of equipment for measuring bores over a large range of sizes has been introduced by British Indicators Limited, Sutton-road, St. Albans, Hertfordshire. The set is made up of a dial-gauge head, together with three interchangeable stem members, each of which is complete with a measuring shoe. Between them, any bore diameter between $\frac{1}{2}$ in. and 2 in. can be measured accurately. Changeover from one size to another takes only a matter of seconds.

COAL DUST PRECIPITATORS

In the final acceptance tests, the electro-precipitators at the National Coal Board's Phurnacite plant at Aberaman, South Wales, an efficiency of 99·93 per cent. was obtained. The precipitators, which were manufactured by Simon-Carves Limited, Cheadle Heath, Stockport, Cheshire, are designed to remove fine coal-dust from the dryer gases. Apart from preventing air pollution, they recover under normal conditions, with two of the three precipitators in operation, over 300 tons of coal-dust a week, which can be returned to the manufacturing plant. The three precipitators are of the vertical gas flow type, and each is designed to deal with about 30,000 cub. ft. per minute of gas at 90 deg. C. They incorporate chute type receiving electrodes whose channels protect the precipitated dust from the eroding effect of the gas stream and so reduce re-entrainment. Special precautions have been taken to reduce the risk of fire, and hinged relief flaps at the gas outlets permit the immediate dispersal of any pressure wave which may develop. An automatic alarm system is fitted, and injectors automatically fill the plant with steam if a fire develops. For the same reason the support insulators for the discharge electrodes are mounted outside the gas stream.

* * *

Permanent magnets and a rotating drum are the elements of this coolant separator, which can be adapted to deal with various liquids.

MAGNETIC SEPARATOR FOR COOLANT

An addition to the range of magnetic equipment made by Rapid Magnetic Machines, Limited, Lombard-street, Birmingham, 12, is the coolant separator illustrated herewith. The machine, which is made in capacities ranging from 10 to 40 gallons per minute by 10 gallon steps, operates by means of Alcomax permanent magnets, and only requires electricity for the small motor which drives the rotating magnetic drum. The separator can be adapted for extracting ferrous impurities from other liquids, such as lubricating oils, potters' slip, chemicals and paints.

Contaminated liquid is fed through a restricted area between the separator housing and the stainless steel cover of the magnetic drum, which rotates in the opposite direction from the flow of liquid. Ferrous particles are attracted to the drum cover, and travel round with it, to be discharged into a chute at the front of the machine, after passing under a roller which squeezes out the liquid remaining in the sludge. The magnetic material clinging to the drum face forms a mechanical filter which traps non-magnetic particles. Cleaned liquid flows from side outlets near the front of the separator.

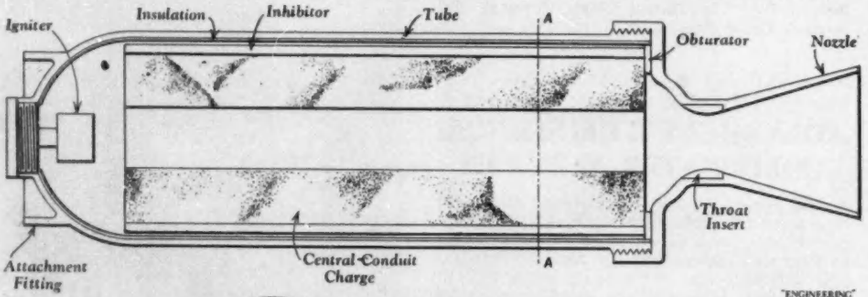
SOLID ROCKETS

We give below a digest of a lecture on "Solid Propellent Rocket Motors" given by Mr. E. T. B. Smith, of the Rocket Propulsion Department, Royal Aircraft Establishment, before the British Interplanetary Society in London.

Solid propellents are fairly inert in storage; liquid propellents, especially oxidants, either evaporate or decompose. The only one in common use which has a fair storage life is red fuming nitric acid which is extremely toxic and corrosive. The cost of solid propellents is high, and their specific impulses are not as high as those of some liquid-propellent combinations.

Solid propellents are to be preferred if the auxiliary equipment for a comparable liquid propellent rocket is likely to weigh an appreciable part of the weight of the propellents (as in small air-to-air missiles); where a rocket is required to be instantly available under almost all climatic conditions (as in sounding rockets for the investigation of showers of particles discharged from the sun); or where it is not desirable to have available a skilled team of men for care and maintenance.

Where sheer performance is the overriding criterion (as in ballistic missiles and satellite launchers), it is necessary to consider not only the specific impulse of the propellents alone, but also the full and empty weights of the complete engine installation, for a given total impulse. The complete absence of pumps, pipes, turbines, auxiliary gas generators and control gear in solid propellent motors is a very favourable feature. Moreover, since the body can be made of thin sheet metal without stiffening frames, solid propellent bodies can be made not much heavier than the tanks for liquid propellents, which often have to withstand some internal pressure to keep the pumps primed, and which in addition may have to be made of materials chosen for their compatibility with propellents rather than for their physical strength. Sections through a typical solid-propellent rocket motor are shown in Fig. 1 above.



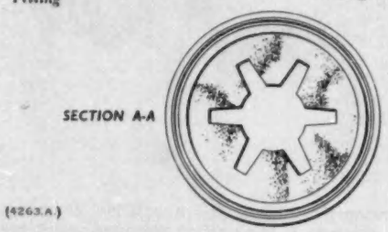


Fig. 1 (above and left) Sections through a typical solid-propellent rocket motor.

SOLID PROPELLENTS: TYPES AND BEHAVIOUR

Double-base propellents such as cordite contain the oxygen required for combustion within the nitrocellulose and nitroglycerine molecules, and form homogeneous gelatinised masses. The newer composite propellents are made of mechanical mixtures of oxidants and fuels, held together with a resinous binder. Frequently, the oxidant takes the form of a ground-up inorganic salt, and the fuel may be provided by the binder itself. Examples are the early asphalt-based propellents produced by J.P.L., and the more recent propellents based on ammonium perchlorate as the oxidant. Such propellents depend for their performance on intimate mixing of the fuel and oxidant and proper control of the particle size.

Composite propellents may be cast into rocket motor bodies as liquids and then cured into rubbery masses, by a suitable choice of binder. They are sufficiently pliable to allow themselves to be bonded to the inner wall of the motor, and yet to resist the formation of cracks produced by the stresses of thermal expansion and contraction. Double-base propellents, however, are not sufficiently flexible to permit this to be done, and a gap has to be left between the body wall and the charge to allow for differential expansion.

CHARGE SHAPE

Most solid propellent rockets are designed to give a thrust-time curve of an almost rectangular shape, although the thrust may be required to rise or fall to some extent during burning to suit aerodynamic or other considerations. The problem of charge design is thus one of shaping the propellent charge so that, as the burning surface recedes, the exposed area of propellent remains substantially constant, or varies in a known and prearranged way. Some surfaces of the charge may be restricted, or inhibited from burning, by coating them with some non-reactive material such as cellulose acetate or ethyl cellulose; in the case of composite propellents, the charge may be inhibited by virtue of its adhesion to the inner wall of the motor tube.

Considering uninhibited charges first, since hot gas is evolved all over the surface of the charge, the rocket body will require to have insulating material applied to the inner surface. This insulant will be heavy and will take up valuable space, so that uninhibited charges are not so suitable for high-performance rockets as are inhibited ones. It is, however, useful to consider the burning characteristics of two uninhibited charges. A long solid stick of propellent, burning on the curved surface, has the surface area diminish as the diameter decreases during burning; thus the pressure-time curve falls rapidly. A tubular charge, burning on the inside as well as the outside, however, maintains the sum of the two surface areas constant, and so the pressure-time curve should have a flat top.

Turning now to inhibited charges (Figs. 2 and 3), the simplest of these is a circular tube with an external coating; the motor tube wall is protected, but since the surface area increases as the charge burns outwards, there is a sharp increase of pressure towards the end of burning, which can only be relieved by using a small ratio of propellent thickness to charge diameter, which means that the cross section of the motor is not filled sufficiently.

The problem is thus to shape the initial burning surface of the charge so that it has the same area as the final surface and maintains this area during burning, without significant variations. This can be done by convoluting the initial inner surface of the charge to a star section, by the use of a number of perforations, or by using a cigarette charge which burns only on the flat surface of one end, all other surfaces being inhibited.

For extremely long burning times, with low thrusts, the cigarette burner is the obvious choice, for medium thrusts and times a slot-compensated tubular charge with a small central hole might be used, while for short times and high thrusts a star-centred or multiperforated charge would be chosen.

So far it has been assumed that a constancy of burning surface area implies constant pressure and thrust. There are, unfortunately, two major deviations from this simple state. One arises from erosion. For example, in an externally-inhibited tubular charge whose initial conduit cross-sectional area is only slightly larger than that of the nozzle, the velocity of the gas through the conduit at the rear end of the charge may produce considerable erosion, which increases the chamber pressure and hence the burning rate all over the exposed surface of the charge. The erosion diminishes rapidly, since the conduit soon becomes much bigger than the throat, and pressure peaks appear at the start of burning. Such behaviour may be eliminated or reduced by deliberately choosing the initial shape of the conduit (of a star-centred or multiperforated charge) so that the pressure, in the absence of erosion, would not rise, imme-

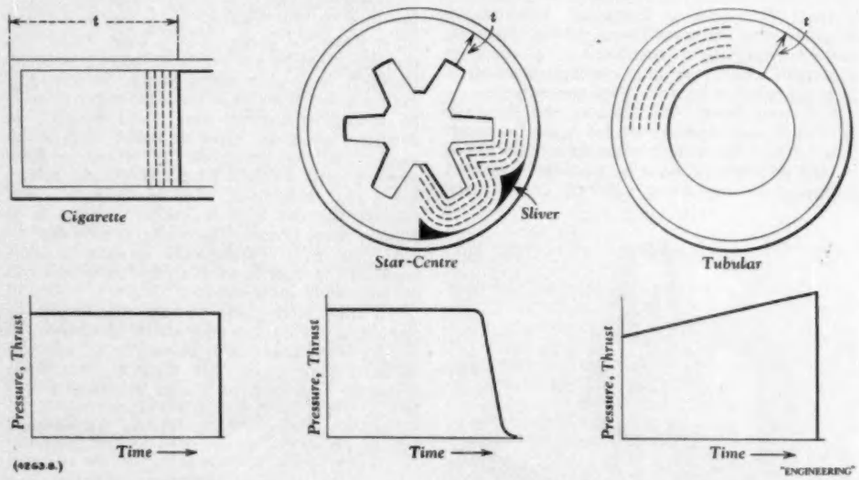


Fig. 2 Simple inhibited charges and their associated thrust/time curves.

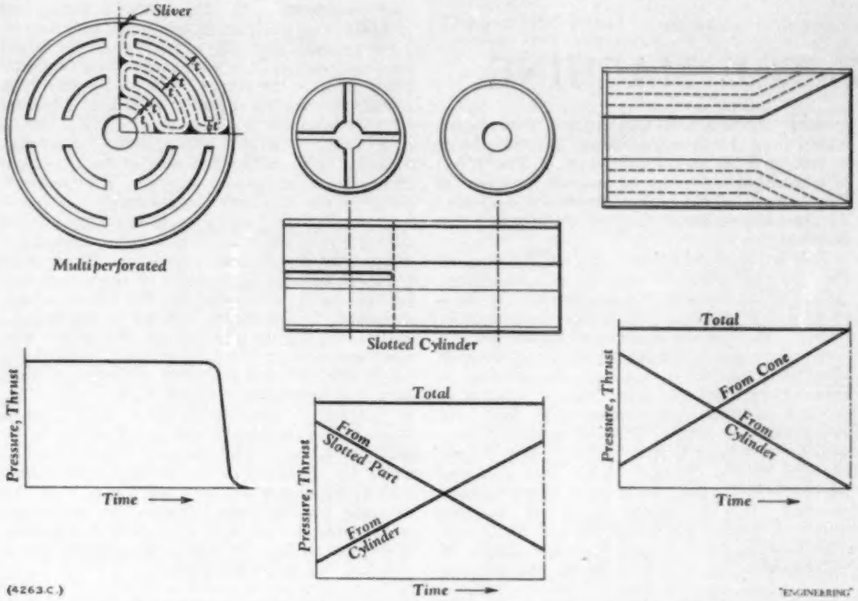


Fig. 3 More complex inhibited charges and their associated thrust/time curves.

diately on ignition, to the general burning level; this permits the erosion to "square-off" the pressure-time curve. More simply but less efficiently, the erosive peaks can be eliminated by making the conduit cross-sectional area larger and reducing the initial gas velocity.

The other deviation is much more subtle, and is less easy to ameliorate: this is an unsteady burning of the charge, during the normal burning time, which is caused by oscillations of the column of hot gas in the charge conduit. Circular conduits are particularly prone to this trouble. Cures which have been tried for this instability include the drilling of holes through the walls of uninhibited tubular charges, and the suspending of metal rods down the centres of the conduits of inhibited charges, both being intended to act as resonance dampers, but the cures are by no means always effective.

BODY COMPONENTS

The inert components of a solid-propellent rocket motor are basically simple, and comprise, generally, a tube, with a large- or full-diameter opening at one end to allow the charge to be introduced, a closure for this opening, and a nozzle through which the combustion gases may expand (Fig. 1).

The body tube, apart from any insulation which may have to be applied to its inner surface, is most frequently made of high-tensile steel, using either welding or manipulative processes, and the nozzle and end closure are usually of steel also. At the combustion temperatures which prevail, up to about 2,900 deg. K. for double-base propellents, no normal engineering materials will persist at all, and only very few (beryllium, molybdenum, tungsten and zirconia, for example) of the expensive materials are any good. This means that almost all solid propellent motors suffer from erosion of the nozzle in the throat region, due to the throat materials melting and being washed down the nozzle. Adequate metal backing has to be provided to ensure that heat is conducted rapidly away from the surface and that the nozzle retains sufficient strength not to distort under the gas pressure; the successful design of a nozzle for a motor which has a high gas temperature and a long burning time is indeed difficult.

COMPUTER FOR REBUILDING

Miniature Machine to Try Out New Designs

A high-speed digital computer, not much larger than a home television set and requiring less power to operate, has been developed by the Bell Telephone Laboratories, New York. This newest addition to the computer family was developed under a United States Air Force contract. It has been named "Leprechaun" and appears in the accompanying illustration.

Leprechaun is to be used for research on programming and logical design in digital computers for military real-time control applications. Mechanical and electrical arrangements are such that the various components can be easily connected, disconnected and interconnected to test proposed new designs. Interconnections consist of jumpers with taper-pin terminals, thus making it possible to set up an entirely new circuit in a relatively short space of time.

Compared with previous computers, Leprechaun operates with relatively few components. Excluding its magnetic cores it uses only about 9,000 electrical components, of which some 5,000 are transistors. A major factor in the reduction in size and power consumption of this computer is the introduction of direct-coupled transistor logic (DCTL) circuitry. The diagram shows a sample of this type of circuitry, and indicates how the reduction in number and variety of components is achieved. One of the aims behind the development of the computer was to demonstrate the feasibility of the DCTL system.

A magnetic core memory is used instead of a magnetic drum. In this way a short access time to stored information is achieved but the total storage available is small. The machine can store 1,024 "words" in its memory, each word consisting of 18 binary digits. Access is provided by coincident-voltage magnetic-core diode switches. Using a system of staggered read drive, a 20 microsecond read-write cycle has been achieved.

Solid-state circuitry is employed in the power supplies. Basically, fast magnetic regulators with transistorised drivers are used. Effective regulation is obtained; for example, the 8 ± 2 volt supply for the memory has a static regulation of ± 1 per cent. for an output current range of 0 to 1·8 amperes, and its dynamic regulation is less than ± 3 per cent. under a pulsing load of 1·6 amperes. The total power dissipation in the computer is about 160 watts, of which 20 watts are dissipated in the DCTL portion. The transistors in this portion only dissipate 2·5 watts, and are mainly selected germanium alloy junction types with an alpha cut-off at 7 Mc/s. A few surface barrier units are used where accurate timing is important, and power transistors develop the high current drives required in the memory.

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SAFE LIGHT

An intrinsically-safe battery lighting set in which the battery is carried by a harness over the shoulders has been produced by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2, and has received official certification by the Ministry of Labour and National Service.

A miner's type lamp is connected by a flexible cable to a separate Neoprene battery container, which is held by a webbing body harness; a heavy gauge elastic harness which will fit over any normal headgear is also supplied. The lamp is pre-focused and is switched on and off by rotation of the front cover. It can be worn in any position on the webbing body harness, or on the elastic head harness. The equipment was primarily developed for use in the oil industry.

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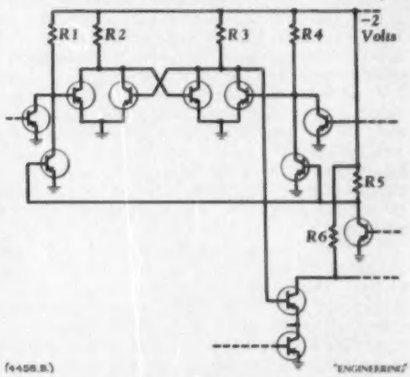
The Leprechaun is a small digital computer with low power consumption. Its circuits can be readily modified and it will be used for research into military computer design.



This typical circuit demonstrates the marked decrease in the number of components when direct-coupled transistor logic circuits are used. The circuit is a portion of a shift register.

Book Reviews

MAKING HIM FIT THE MACHINE

Man Unlimited: Technology's Challenge to Human Endurance. By HEINZ GARTMANN. Translated from the German by Richard and Clara Winston. *Jonathan Cape, Limited, 30 Bedford-square, London, W.C.*1. (18*s.*)

" How I do love courage in a man ! " is a line never far from the lips of every heroine in melodrama, and the words, whether spoken or not, ring a bell in the mind of every member of the audience. Here are records in plenty of men of courage and feats of valour; not the courage of a man with a drawn sword in his hand, but the courage of Lord Jim.

The emphasis of this book is on speed, acceleration, reaction-time, and the response of the anthropological complex of inter-related servo systems which make the human machine so versatile and flexible. Speed, of course, if it means no more than velocity, is entirely relative and subjective. But the sense of speed runs right through the text, if it is held to imply not simply rate of progress but rapidity of motion: a product of frequency and amplitude, the accomplishment of a large number of discrete motions in a short period of time. Speed as velocity is not altogether dismissed; but the relativity of velocity is made abundantly plain by the story of the air temperature handicap, the frantic scramble for the last few subsonic miles per hour in the late summer and early autumn of 1953. How quickly the big black headlines of yesterday fade, when the page of history is seen in the perspective of to-day; for this is one of the less effective of the author's narrative paragraphs.

The word " paragraph " is used advisedly, for the whole book seems on first reading to be a collection of paragraphs, rather than the ordered sequence of polished essays that would have been expected by and produced for an earlier generation. But the style matches the subject. The breathtaking rapidity with which the author leaps from one idea or one illustration to another —his agile mind roving restlessly at a pace that disconcerts the relatively sluggish reader—is only surpassed by the lightning response of his hero, the machine-operator scanning a vast instrument panel at hitherto unknown frequency. " Slow reaction," we are told, " is by no means man's inescapable destiny. The irresolute learn . . . to react swiftly; the timorous gain self-confident calm . . . Thus there emerges out of the psycho-technical torture-chamber the modern principle of systematic training of the nervous system . . . Happy the generation to come in which not only a privileged few, but the majority of people, will be able to develop all their powers to the fullest . . . "

What lies behind this intense interest in the ultimate performance of the human machine? Space-flight and interplanetary travel of course. For, in the early stages of accomplishment, these feats will tax to the limit the physical powers of the first space-men—if only because the marginal performance of the first vehicles will leave little or nothing in hand for the comfort of their riders. Space-flight requires investigation not only of the limiting terrestrial stresses on the human frame but of new experiences: of weightlessness, and of being beyond the compass of diurnal time. The story of how these extra-terrestrial experiences are being investigated is well told.

The inevitability of space-flight is more apparent to-day than was the possibility of winged transport sixty years ago. All the mechanical and physiological obstacles are being overcome. But what of the heat-barriers? In respect of one of these the author gives question and answer as follows: " At 400 miles up the prevailing temperature is 4,000 degrees Fahrenheit. Steel melts at 2,460, platinum at 3,227. How could an aircraft ever endure such an " inferno "? The curious fact is that these extreme temperatures would leave the aircraft quite cool. In these hot strata the number of molecules is extraordinarily low . . . The speed of their impact against the wall of the plane is the measure of the high temperature, but their numbers are so small that the plane would not be heated."

This is sound scientific sense, as is almost all the text that concerns matters of speculation. At one point, however, the author falls heavily—in adopting a once fashionable sound-barrier fallacy. Here is the alarming picture he paints: " We may imagine the consequences if a Hustler were permitted to roar across the country at supersonic speeds while remaining at low altitudes. A path of destruction about 1,000 feet wide would mark its route. Gusts of hurricane force would smash houses, vehicles, ships, would mow frightful swaths through fields, orchards and woods, would wreak destruction wherever they passed." This is science fiction at its very worst. Consider the facts: the aircraft travels over 1,000 ft. in a second, so that the area of " destruction " is over 20 acres per second; the fuel consumed, on the author's figure of 35,000 h.p. at sonic speed, can weigh only two or three pounds, and only a fraction of the latent chemical energy is available for " destruction." Thus we have the preposterous assumption that devastation of the intensity described covering over 20 acres could be caused by the equivalent of a pound or so of high explosive. However, a single lapse leaves the author with a commendably high score, though the reader's confidence is momentarily shaken.

The concluding chapters, introducing atomic energy and automation, help to lower the tension created by the hitherto dominant theme of a twentieth-century martyrdom of man, and one returns to a quotation, in the introduction, attributed to Dessauer: " When archaeologists uncover skeletons and are in doubt whether these are remains of true men or of pre-human forms, the question is settled if they find tools with the bones—flint knives, arrow heads or fist-hatchets." Chesterton would have looked rather for the instrument with which man drew the pictures on the wall of the cave; for man is not made by mechanical proficiency alone. The author, for all his apparent worship of man the machine, reveals in the epilogue his awareness of the need for intenser training and discipline of the non-technological faculties also, if man is to realise his unlimited destiny.

FUNDAMENTALS OF FOUNDATIONS

Principles of Engineering Geology and Geotechnics. By DIMITRI P. KRYNINE and WILLIAM R. JUDD. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (10 dols); and *Mc-Graw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.*4. (75*s.*)

This is yet a further book in the McGraw-Hill Civil Engineering Series which includes such well-known text-books as Babbitt and Doland on Water Supply; Dunham on Reinforced Concrete; and Tschebotarioff on Soil Mechanics. This latest edition conforms to the high standard set by the others in the series. It is well printed, illustrated and referenced and in addition, but most important, it accomplishes its avowed purpose of presenting as a text-book the basic geotechnical principles underlying civil engineering design and construction.

The authors, in their preface, claim a second purpose for the book, namely that it is a work of reference for practising civil engineers and engineering geologists. This claim is, however, not as easily allowed. As a text-book the book is excellent, but as a work of reference some features which might have received more full treatment have had to be reduced to allow the inclusion of simple explanatory chapters. For example in a work of reference the chapters on the elements of soil mechanics and the engineering properties of rocks might have been omitted; the former is given more detailed treatment in Tschebotarioff's book. More full treatment might have been given to some interesting problems such as beach engineering, landslides, and control of ground water—these last two subjects are fully dealt with in that excellent book on some problems of engineering geology, namely the Berkey volume published by the Geological Society of America. In a work of reference one might also have expected a more complete treatment of the mechanics of rocks; it is now more than 20 years since the work of Griggs at Harvard University on the deformation of rocks under high confining pressures has shown that the terms brittle and plastic must be used with care when discussing the engineering properties of rocks, and yet in the small section which deals with this important subject little mention is made of the effects of confining pressures on the strength of rocks.

These criticisms only refer to the claim for the book to be a work of reference. In one important aspect, however, the book is well served and that is in its references. Most of the problems which beset a practising civil engineer are mentioned, even if only in passing, but at the end of each chapter some 20 to 30 references cover the subject more fully; it is to be regretted that these appear to be confined to American sources, but in an American text-book this is to be expected. For engineers who have to deal with such problems there is an interesting chapter on frost and permafrost in which methods of constructing foundations and buildings on such ground are discussed; in addition there is a chapter on earthquakes and the seismic design of structures.

The book, which contains 19 chapters, finishes with a chapter on some legal aspects of geotechnics but, although the *corpus juris* of both the United States and Britain have a common foundation, the English laws of contract and of tort have had their own peculiar development and it would be as well for English students and engineers to ignore this chapter.

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NEW BOOKS

The Manufacture of Iron and Steel. Vol. 1: Iron Production. By G. REGINALD BASHFORTH. Second edition revised. *Chapman and Hall, Limited, 37 Essex-street, London, W.C.*2. (45*s.*)

Nine years have elapsed since the first edition of this work was published, and while leaving the original objectives unaltered, namely, to provide a text-book for the student and a reference work for the busy industrialist, an effort has been made to bring the subject up to date by the inclusion of new information and by the description of new processes and new methods. The present edition contains 306 pages as compared with the 228 pages of the first edition, and, among the new topics dealt with, are high top-pressure design and equipment, the low-shaft furnace and sponge-iron production.

X-and Gamma-Ray Safety Precautions. *The British Welding Research Association, 29 Park-crescent, London, W.*1. (2*s.*)

The aim of this booklet of 13 pages is to provide clear and simple information on the hazards which may be encountered by persons entering radioactive zones, and the precautions to be taken to prevent injurious effects. The booklet is divided into four sections, dealing respectively, with radiation hazards, the maximum permissible dose, precautions against X-rays and gamma-rays (with examples) and the manipulation of isotopes.

Stress Corrosion Cracking and Embrittlement. Edited by WILLIAM D. ROBERTSON. *John Wiley and Sons, Inc., 440 Fourth-avenue, New York 16, N.Y., U.S.A.* (7.50 dols.); and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.*2. (60*s.*)

Held in Boston, U.S.A., in October, 1954, under the

auspices of the Corrosion Division of the Electrochemical Society, a symposium on "Stress Corrosion Cracking," reported in the present volume, deals with the major developments in this particular field of corrosion and embrittlement that have taken place in the past twelve years. The contents comprise 14 papers emanating from four countries and reflecting work of importance conducted in university laboratories and in industrial centres. British authors include Dr. U. R. Evans, Dr. J. G. Hines, Dr. T. P. Hoar, Dr. R. N. Parkins and Professor Bruce Chalmers (now of Harvard University).

Standard Samples: A Catalog of Reference Materials. National Bureau of Standards Circular 552. Second edition. *The Superintendent of Documents, U.S. Government Printing Office, Washington* 25, *D.C., U.S.A.* (25 *cents.*)

The catalogue contains a descriptive list of the standard samples issued by the National Bureau of Standards, comprising steels, irons, alloys, ceramic materials, paraffins and other organic compounds, radioactive substances, india rubbers and rubber compounding materials, cements, pigments and light-sensitive papers. The weights and prices of each standard supplied and directions for ordering them are furnished. Tables of analyses of the various standards are included.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Technical and Commercial Photographic Services. W. RALSTON LTD., 334 West George-street, Glasgow, C.2. Science and industry provide vast opportunities for expert photography. "A Fresh Voyage After One Hundred Years of Photography" sets out a brief account of this firm's history and present development, and supplies details of their wide range of commercial, industrial and scientific services in photography, especially throughout Scotland. Illustrated brochure, in colours.

Milling Machines. B. ELLIOTT & CO. LTD., Victoria Works, Willesden, London, N.W.10. Details of a range of milling machines, consisting of 17 different models, with table sizes from 36 in. by 9 in. to 72 in. by 15 in. The machines are available as plain, universal or vertical type, or with an automatic milling cycle. Illustrated booklet, which also gives details of extra equipment. A new addition to the range, the "Victomatic" 0-18 in. automatic cycle machine, is described in a separate leaflet.

Low-Voltage Transformers. FOSTER TRANSFORMERS, LTD., South Wimbledon, London, S.W.19. Fixed location totally enclosed low voltage transformers of outputs up to 1,000 volt-amperes for use at 650 volts. Open type low-voltage transformers of outputs up to 4,500 volt-amperes for use on circuits up to 650 volts. Also three-phase oil-immersed double wound indoor transformers up to 4,500 volt-amperes. Technical details. Illustrated leaflets.

Twist Drills. SHEFFIELD TWIST DRILL & STEEL CO. LTD., Summerfield-street, Sheffield, 11. Revised handbook of information on drills, incorporating the basic information on sizes, speeds and feeds, and hints on use and maintenance, together with a number of new features. These include data on special-purpose drills, and on the drilling of the new materials such as plastics and titanium. Illustrated booklet.

Building Ventilation. ROBERTSON THAIN, LTD., Ellesmere Port, Wirral, Cheshire. New edition of the Robertson Data Book, giving information on the exhaust capacity of various types of ventilators. Dimensions and weights of ventilators are also tabulated, and notes are provided on natural ventilation, together with general data of use in ventilation calculations. Illustrated brochure.

Used and Re-Built Machine Tools. SOAG MACHINE TOOLS, LTD., Juxon Street, Lambeth, London, S.E.11. Details of a large range of machines, including boring, drilling, filing and sawing, gear cutting, grinding, milling, shaping and slotting machines, lathes, power presses and hammers. Illustrated catalogue.

Handling Equipment for Drums and Barrels. POWELL & CO., Burry Port, Carmarthenshire. Trucks and barrows for lifting and transporting drums, barrels, bins, and other bulky one-piece loads Illustrated brochure.

On the Shelf

By Frank H. Smith

Perhaps one of the most disconcerting inquiries that comes to librarians is the request for "figures" on any particular subject. Years' outputs, passenger-miles travelled, average wage rates, annual consumptions and the like all seem to be hidden away somewhere, if only one can find them when they are wanted. The oil industry, at any rate, is well served by B.P.'s "Statistical Review of the World Oil Industry," but I would not mind betting that the poor oil librarian will not find the exact table in it that the inquirer of the moment wants.

A new journal that is symptomatic of the age is *Industrial Screen* (Robin Publications, Limited, 136 Grand Buildings, London, W.C.2) which costs 15*s.* for six issues a year. The "Screen," by the way, is the cinema variety—not the sieve or security types. The title of the journal is fairly self-explanatory and it will be appreciated that with television and the increasing awareness of industry of the value of film there is much scope for such a periodical. I am surprised, in fact, that with so much material about there are only 22 pages to this first number.

The drive for technical education really seems to have the authorities in a hugger-mugger. The latest official pronouncements show their concern for the humanities, which "must not be forgotten in the Government's all out drive for expansion of technical education." Circular No. 323 of the Ministry of Education consists of three closely typewritten pages of directive on the development of liberal education. The onus is thrown on the staff of broadening the students' outlook and, *inter alia*, "a well-stocked and attractive library is essential to a full and liberal education and to the general life of a college." This, coming on top of recommended expenditure for a technical library, is going to require a versatile librarian who knows how to make silk purses out of sows' ears. If the college staffs are to do all that is required in the circular some of the backroom boys can set about inventing a clock that crowds 48 hours into 24. Both staff and students will need it.

"On the Shelf" is directed mainly at librarians but I cannot resist including an item I have culled from *Soviet Weekly* which should interest the general reader (and Mr. Tommy Trinder). A Mr. M. Azatyan, of Thilisi, Georgia, is shown demonstrating his new "reverse-gear" bicycle. "In reverse, the cyclist pedals backwards while the cycle continues to go forwards." The idea is to rest the rider's legs by changing the stress on his muscles, but I think, myself, it is just another trick to fool his competitors in the next Olympics.

Although Norbert Wiener introduced the word "cybernetics" as the title of his famous book in 1948, it was probably only six or seven years ago that the subject started to acquire a sizeable literature requiring serious attention. The Library Association have now produced a "Special Subject List" by F. R. Taylor, of the Manchester Technical Library, giving 144 references. In an introduction the compiler traces the origins of the science both etymologically and in the field of literature. He says that the "first ever" article (it is always interesting to know how these things start) was Rosenblueth, Wiener and Bigelon's "Behaviour, purpose and teleology" in *Philosophy of Science*, vol. 10, 1943. So it looks as though cybernetics might have been teleology. The subject list is No. 17 and costs 1*s.* 3*d.* from the Library Association, Chaucer House, Malet Place, London, W.C.1.

SNAP-BOTTLES FOR PNEUMATIC EMERGENCY SERVICES

A range of "snap" air bottles for aircraft emergency services has now been added to the snap-jacks manufactured by the Hymatic Engineering Company, Limited, of Redditch, Worcestershire.

Snap-bottles can actuate simple jacks without resource to any external pressure system. They can be installed some distance from the jack when space is restricted. An additional advantage is that pressure can be checked and the bottle readily re-charged.

Fitted with a pressure gauge and ground charging connections, the snap-bottle works on the bursting-disc principle, the compressed air being released either electrically or mechanically by removing the support to a thin aluminium-foil

The Hymatic R.E.S.5 snap bottle.

diaphragm. The mechanical type is operated by a lever with a simple rod or cable connection. In the electrical version, a small charge is exploded to displace the support. Although the principal application for snap-bottles is for "one-shot" emergency application, the foil diaphragm can be replaced for re-use.

Several basic types of snap-bottles are available with working pressures ranging up to 3,000 lb. per sq. in. and capacities up to 30 cub. in. Bottles of greater capacity can be supplied as required. A typical example of the range is shown in the accompanying illustration. It is the R.E.S.5, a mechanically-operated version weighing only 2·24 lb.

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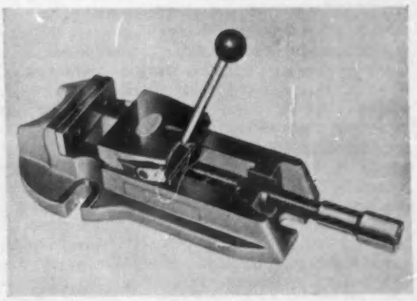
QUICK-ACTION VICE

The machine vice illustrated below has been introduced by Associated Steels and Tools, Limited, Sedgley-street, Wolverhampton. It has a cam-operated jaw which, when the handle is depressed, moves forward, its leading edge taking an angular path. The clamping is therefore downwards. A hand-operated screw is provided for pre-setting the jaw to its working position. The jaws are 4 in. wide and will open to a maximum gap of 4½ in. A clamping pressure of up to 1 ton can be exerted by the jaws.



The clamping jaw in this vice is cam-operated and exerts a downward pull.

HIGH-VACUUM METAL-MELTING EQUIPMENT

By the terms of an agreement arrived at in March between Wild-Barfield Electric Furnaces, Limited, Elecfurn Works, Watford By-pass, Watford, Hertfordshire, and the National Research Corporation, of Massachusetts, U.S.A., the British firm is to manufacture vacuum-melting and vacuum heat-treatment and analysing equipment of N.R.C. design. Data regarding some of the furnaces involved are now available for publication.

Since 1943 the American firm has carried out continuous research into problems concerning vacuum metallurgy and has produced appararatus ranging in capacity from 2 lb. to 10,000 lb. We are informed that upwards of 300 vacuum

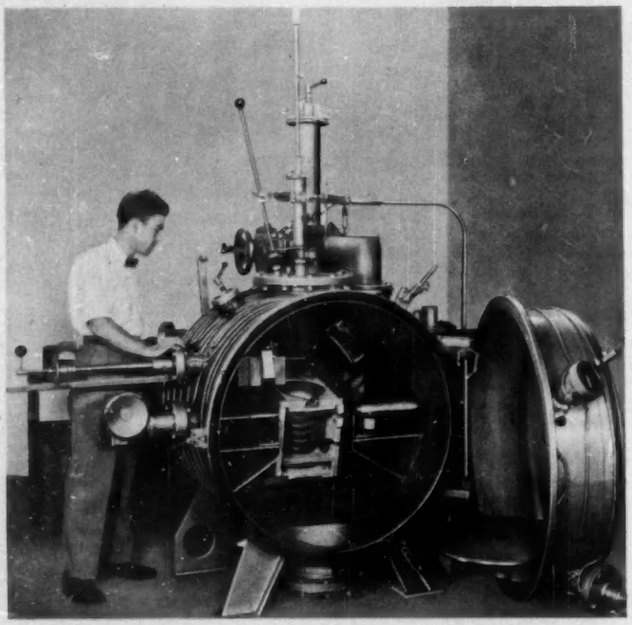


Fig. 1 Vacuum electric furnace of the induction type having a capacity of 50 lb. of metal. The furnace chamber is constructed of stainless steel and co-axial leads conduct the power and the cooling water to the coil. A removable ceramic crucible cover prevents the loss of heat from the melt and also protects the furnace chamber and the operator from radiant heat.

furnaces of all types have been made and are operating satisfactorily. The National Research Corporation are also producing standard vacuum analysis equipment for determining the quantities of oxygen, hydrogen and nitrogen present in metals. These have been adopted in many works laboratories, particularly those connected with the production and use of titanium and its alloys.

Vacuum furnaces of the induction or arc type are available and standard vacuum induction furnaces can be supplied having capacities of from 12 lb. to 2,400 lb. of steel. That shown in Fig. 1 has a capacity of 50 lb. The furnace chambers are constructed of stainless steel which is both easy to clean and non-magnetic, thus avoiding loss of electrical efficiency through inductive coupling to the tank. The operating controls are conveniently grouped and ample windows are provided to enable the process to be watched. Large-capacity bulk-charging mechanisms and multiple alloy containers are supplied to enable the full use of the crucible capacity to be made and to give adequate flexibility. The pumping system provided exhausts the system rapidly and maintains a high vacuum during the operation period. Vacuum gauges arranged at important points in the furnace chamber and pumping system, give instantaneous readings of the pressure.

Variable capacitor banks and transformers are supplied in order to keep pace with the changing electrical load resulting from the melting of the charge, thereby reducing power loss. Co-axial leads conduct the power and the cooling water, through the vacuum chamber, to the coil. They are mounted in such a manner that the crucible can be tilted without cutting off the power supply.

A removable crucible cover provides a shield which prevents the loss of heat from the charge and thereby not only speeds up the melting cycle but also protects the furnace chamber and the operator from radiant heat. If desired, immersion thermocouples are provided, thus helping to attain high-quality melts and eliminating the possibility of overheating the charge. Mould-positioning devices, allowing the use of more than one mould per melt, may also be fitted if required.

Air locks, which are standard on the larger furnaces and optional on the smaller ones, permit the charging of materials and the removal of ingots without breaking the vacuum or cooling the crucible in the furnace chamber. This increases productivity and prolongs the life of crucibles.

The agreement entered into by Wild-Barfield also covers vacuum arc furnaces of the cold-mould and skull types with consumable or non-consumable electrodes. A diagrammatic view of a non-consumable electrode type of cold-mould arc furnace is shown in Fig. 2. At the commencement of melting, the water-cooled mould cup is raised near the top of the water-cooled copper mould. As melting proceeds and the ingot is formed, the mould cup is slowly lowered inside the mould. The power circuit is completed through the mould cup and the sides of the mould are "floating" electrically to minimise arcing to the mould wall. A variable-speed vibrating charging mechanism feeds the charge into the mould. The water-cooled electrode assembly rotates about its axis, the sweep radius being changeable to obtain complete melting of the charge.

In consumable-electrode melting, an electrode is fabricated of the material to be melted. The electrode is enclosed in a vacuum-tight tower and it is melted by its own arc into a water-cooled copper crucible or mould; the electrode is fed by a variable-speed drive. Power is supplied through a water-cooled copper contact. On account of the rapid heat withdrawal through the copper walls of the mould, the metal solidifies instantly upon contact with the mould so that there is no opportunity for contamination from the copper-mould material. Standard equipments are produced having an ingot size equivalent to 100 lb. of titanium, but furnaces are in operation which cast ingots of that metal having dimensions of approximately 20 in. in diameter by 4 ft. in length.

Requirements imposed by the more complex titanium and zirconium alloys are among the considerations which have led to the development of skull melting. This, basically, is an arc-melting technique in which the melting is conducted in a metal bowl or skull having the same composition as the metal being melted. This ensures that there can be no contamination of the melt as long as the skull retains its solid form. A standard furnace having a capacity of 50 lb. of molten titanium is available and a diagram of this furnace is shown in Fig. 3.

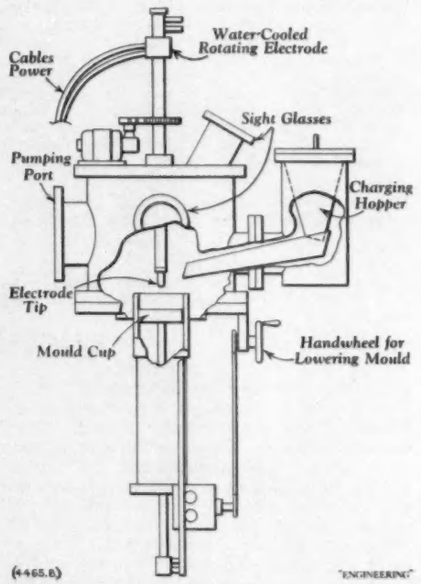


Fig. 2 Non-consumable electrode cold-mould arc vacuum furnace. As melting proceeds the water-cooled mould cup is lowered inside the mould. The water-cooled electrode assembly rotates about its axis, and the charging hopper is vibrated.

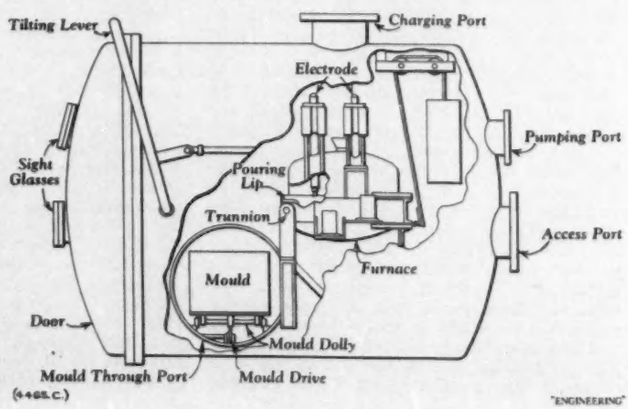


Fig. 3 Skull-type furnace, in which melting is carried out by the arc-melting technique in a metallic bowl or skull of the same composition as the alloy being melted.

LOW-SPEED WIND TUNNEL FOR BRISTOL

Claimed to be the largest wind tunnel of wooden construction in the world and one of the two largest industrially-owned tunnels in the United Kingdom, a new low-speed wind tunnel has recently been inaugurated at Bristol Aircraft Limited, Filton. It will be used, in conjunction with the supersonic tunnel completed in 1952, for detail design and development work on the company's guided missiles, and rotary and fixed wing projects.

The tunnel is of the closed-circuit type. The working section is 12 ft. wide by 10 ft. high and 25 ft. long, and will accommodate models up to 9 ft. span. The models can be fitted with electrically-driven propellers for studying slip-stream effects, and the exhaust from jet pipes can be simulated by compressed air. The tunnel is also equipped to study jet flaps, and flexible models will be used for flutter investigation.

The attitude of the suspended model is governed remotely by the operator in charge of the control console, and can be varied in pitch and yaw at any time during test, and the effect of rolling gauged from the results obtained.

The forces generated are measured along three axes by a mechanically-operated simultaneous six-component virtual-centre balance, and the observations taken by three operators at the console. Movable weights on the weigh-beams of the balance can be adjusted electrically from the console to enable the beams to be set to zero at the beginning of a run and at the preselected test conditions—an adjustment that will be made automatic in due course.

Two sets of fixed vanes mounted on the nacelle each side of the fan eliminate any rotation imparted to the air. The fan itself is 22 ft. in diameter and has a chord of over 2 ft.

The balance mechanism, claimed to be one of the most sensitive wind-tunnel balances yet designed, is contained in a heat-controlled box maintained at a temperature of 80 deg. F. with a maximum variation not greater than 1 deg. each way. To reduce vibration to a minimum, it is isolated from the surrounding structures, being supported on separate foundations. Balance readings, pressure and temperature data and a record of the model attitude are punched on cards and passed hourly to the Deuce computer for analysis. Later, a permanent land line is to connect the wind tunnel with the Bristol Mathematical Services Group. Two liquid manometers, of 100 tubes each, are installed for plotting pressure distributions, and tufting and oil film techniques are normally used for flow visualisation.

The air velocity is under the control of the operator in charge of the console, and once the appropriate velocity has been selected it can be maintained constant within 0·1 per cent. by automatic regulation of the power supply to the fan.

Immediately downstream of the working section, which has an area of 112 sq. ft., the rate of expansion of the tunnel is restricted to the equivalent of a cone angle of 5 deg. The area of the fan disc is 315 sq. ft., and the largest section of the tunnel, between the fourth corner and the contraction section, has an area of 745 sq. ft., is 31 ft. wide and nearly 26 ft. high. In the contraction section, which is heavily braced to the main building to resist an axial load of 32 tons, the contraction ratio is 6·65 to 1.

A calculated form for the contraction section, which was predicted to introduce only acceptable degrees of error, was checked by means of a model in an electrolytic tank, in which there is a correspondence between voltages and the distribution of velocities. The voltage found at any point indicates the velocity there and, as it is easily measured, provides a quick and accurate method of investigating fluid flow.

At the end of the working section there is a narrow slot running circumferentially round the tunnel to permit it to "breathe." Two gauze screens are placed at the beginning of the contraction section to help straighten the airflow, and steel-wire guards are positioned immediately before the first corner after the working section to stop any loose object which might be blown from the working section.

The fan nacelle is 56 ft. long and the fan itself is 22 ft. in diameter. The seven fixed-pitch blades have a chord of rather more than 2 ft. and are made of laminated mahogany covered with an acetate sheet. The blade tips are square and extend into a gully 2½ in. deep running round the periphery of the duct at the plane of the fan. The bottom of the gully is lined with balsa wood so that any small solid object reaching the fan would be driven out of harm's way instead of jamming between the blade tip and the tunnel wall. Like the balance mechanism, the fan is isolated from neighbouring structures and supported on separate foundations.

Air approaching the fan passes through a set of six pre-rotational vanes which give a swirl contrary in rotation to that of the fan. Beyond the fan another set of six straightener vanes removes any rotation induced into the airstream. The number of vanes in the fan and in the static blades is dissimilar in order to avoid the pronounced "beat" which would occur if all the fan blades were to align simultaneously with the static vanes.

The designed power of the tunnel is 1,850 h.p., provided by one 850 h.p. alternating-current motor and two 550 h.p. direct-current motors, giving a total available horse-power of 1,950. The speed of the fan is automatically controlled through the direct-current motors in response to the pressure difference across the contraction section, which is measured by pressure tappings each end and recorded by an automanometer.

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FLOATING DOCK FOR ADMIRALTY

A new floating dock (A.F.D. 58) for the Admiralty was launched on June 30, 1957, by the Furness Shipbuilding Company, Haverton Hill-on-Tees, Billingham. The dock, which can lift ships up to 6,000 tons displacement, was designed by Clark and Standfield, consulting engineers, in conjunction with the Director of Naval Construction, Admiralty. It is expected the dock will be used by the Royal Navy, in the first instance, in the Clyde area to replace A.F.D. 19 for docking destroyers and submarines. The principal particulars are: overall length, 450 ft.; overall width, 92 ft.; clear width inside walls, 62 ft.; and overall depth of dock, 43 ft.

The dock is fully equipped to operate as a self-contained unit, having travelling cranes on each wall, adequate Diesel generating capacity, workshop and store spaces. Accommodation to modern Naval standards is provided for the Naval dock crew and for the crew of the ship being docked. Special features to cater for tropical and cold weather service are incorporated.

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MEMORY ADDED TO PUNCHED-CARD CALCULATOR

The techniques of electronic computation, originally developed for the solution of complex problems in mathematics, are becoming applied with increasing frequency to the more routine calculations of everyday business. The British Tabulating Machine Company, Limited, 17 Park-lane, London, W.1, have recently announced the production of the Hollerith 555 electronic calculator, which embodies in a punched-card machine certain features usually found only in more complex computers.

The primary advantage of this machine, over the previous models in the Hollerith range, lies in its greater capacity for doing calculating work upon the information put into it. Its speed of taking in information and of punching out results is 6,000 cards per hour. But the volume of calculations which can be carried out in the time available between each card passage is five times greater than previous machines in the Hollerith range. New facilities include magnetic drum storage, extended programmes, provision for the extraction of square roots and for carrying out iterative operations, and marginal testing and checking. The memory drum has a capacity of 105 ten digit words; programming is achieved by the setting of pluggable control panels; preventive maintenance is by switch-control units. The last enable sections of the calculator to be tested daily so as to detect in advance changes of condition likely to give rise to failure. Output is by punched cards.

DIAGNOSIS AND PRESCRIPTION

A Power Analysis for Underdeveloped Countries

ENERGY and wealth are intimately linked. Native resources and skill in using them make a country rich, but energy is the catalyst by which the yield is multiplied. Conversely, it is the failure to make wide and effective use of energy that characterises the underdeveloped countries. The part to be played by power in the development of these territories was the theme of the Eleventh Sectional Meeting of the World Power Conference held recently in Belgrade, and this article is based on the papers and addresses presented on that occasion. It became apparent early in the meeting that no two countries, developed or underdeveloped, were alike in their requirements, so that in assessing power needs, each country, and indeed each region, would have to be treated on its merits. The process of assessment might conveniently be divided into two stages: diagnosis, and prescription, since to prescribe a power plant or system without previously diagnosing the regional situation might prove costly, if not disastrous. The first stage would be to examine national and local conditions affecting choice of power supply; and the second would be to select a power scheme, project or prime mover appropriate to those conditions. The present article is in two sections corresponding to these stages, each section being a discussion of factors involved in making such a survey.

Before proceeding to the principal part of the article it is necessary to define more precisely —though this is not easy—what is meant by an underdeveloped country, and to determine whether such a country may legitimately be studied in terms of experience gained in more advanced countries.

According to some speakers, all countries are underdeveloped since there are no signs of power saturation yet, and it is certainly true that parts even of America and Europe are far behind their neighbours in living standards. The President of the World Power Conference, Ing. Franz Holzinger, defined as underdeveloped those countries which had been so far unable to demonstrate the economic and technical capacities displayed by other countries, while Mr. J. Stanovnik of Yugoslavia attributed underdevelopment to low capital formation. Mr. Stanovnik also referred to illiteracy, low percentage of employment in secondary and tertiary economic activities, low average life expectancy and low energy consumption per head as symptoms of economic backwardness. Later speakers classified various degrees or forms of underdevelopment.

One approach was to consider in turn countries with resources and industry, with industry but no resources, with resources but no industry, and without either; while other delegates added further divisions into large and small countries, large and small populations, and areas inside and outside the main industrial orbits. Possibly the most useful classification, however, was that made by Father E. S. de Breuvery of the United Nations Secretariat, who described four zones or classes of underdeveloped territory. The first comprised areas where an electric grid already existed or could be envisaged; here there would be some industry and a transport system. The second zone included regions in which for cost reasons no interconnected grid could be foreseen; here isolated power stations might be built. In the third zone, conventional power stations were economically excluded owing to the long distances over which fuel would have to be transported; here non-conventional power sources might be used—small nuclear reactors and intermittent sources employing solar or wind energy. The fourth zone consisted of agricultural areas which were likely to remain purely agricultural in the future; here power would be required solely for radiocommunication, lighting, irrigation and possibly for transforming salt or brackish water into sweet water, and as in zone three intermittent sources would be sufficient. But perhaps for most purposes it will be sufficient to quote the definition given by Mr. Gunnar Myrdal, Executive Secretary of the Economic Commission for Europe, who described underdeveloped countries simply as " poor countries."[1]

What features contribute to the poverty of these areas? The following factors[2] have been listed for the E.C.A.F.E. (United Nations Economic Commission for Asia and Far East) regions. They are densely populated, accounting for 50 per cent. of the world's total population, though only 16 per cent. of the land area (but some underdeveloped territories are sparsely populated, namely the Sahara and Siberia). The development of industries is still in an early stage and agriculture continues to predominate (but arable land is a primary resource and if intensive farming were adopted might well assist in raising the standard of living[3]). The productivity of labour is low. Mineral resources are comparatively meagre, and their utilisation is still at a primitive stage (but the underdeveloped countries of the Middle East and the Caribbean are the world's principal fuel exporters[4] and both India and Yugoslavia, for example, have vast unused hydro-electric resources.[1] The capital available for development is insufficient. And finally, experienced engineers and managers are few.

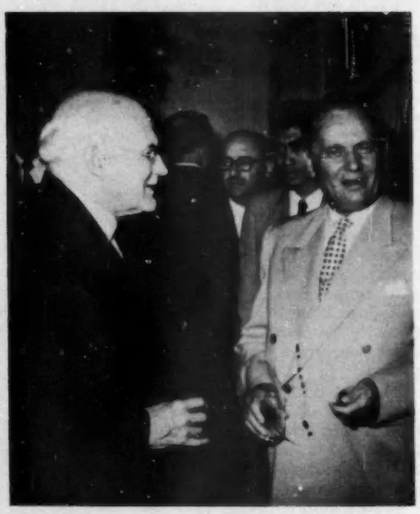
There are several ways in which an energy supply can help to overcome national poverty and raise living standards; these have been listed by Sir Harold Hartley[5] and are as follows: by providing the power and heat needed by industry (and also by increasing industrial output per man[6]); by improving the efficiency of agriculture; by providing communications and transport; and lastly, by raising the standard of comfort and health in home and factory.

It has already been established that there is a significant correlation between energy consumption in any one country and its national income per head,[7] and this might be regarded as a basis for applying Western experience to the underdeveloped countries. But to conclude that optimum investment in power plant could be accurately estimated from analyses of this kind would be unduly optimistic. For example, in comparing two countries the same correlation does not apply: thus although Norway, with an annual energy consumption (in 1954) of 6,484 kWh per inhabitant, uses almost 10 times as much power per capita as Denmark (749 kWh), the two countries are roughly equal in gross national product. Abundant hydro-electric resources in Norway have led to the development of energy consuming industries and to cheap power and hence prodigal consumption; it is significant too that Denmark is to a great extent dependent on agriculture. (The corresponding annual energy consumptions in Britain and the United States are 1,585 kWh and 3,393 kWh.)[6]

In addition to power consumption there are social, economic and political factors[8] likely to influence energy investment such as willingness to sacrifice the present to the future,[9] the desire for diversity of production,[1] or the " lure of industrialisation,"[5] and even the difference between a cold and a warm climate will seriously affect load requirements.[10] Patterns of industrial growth are necessarily dissimilar, particularly over different periods of time, for the situation in Britain at the beginning of the Industrial Revolution bears little relationship to that in a country now starting its development, where at least a planned growth in the light of Western technical knowledge can be undertaken.[11] In a discussion, M. Pierre Maillet remarked that errors in exchange rates of 20 to 25 per cent. and the difficulty of defining an index of national activity added to the confusion, while the availability of statistical data and its variation in accuracy with age further complicated the problem.[3]

Nevertheless, there can be little doubt that the experience of advanced countries, if applied carefully, can be useful to the underdeveloped countries; indeed, as Mr. R. Y. Sanders remarked in a discussion, there would be little point in delegates attending the meeting were this not so. Methods of analysis have been

The Trade Unions Building in Belgrade, Yugoslavia, where the Eleventh Sectional Meeting of the World Power Conference has recently been held. The meeting took as its theme: " Power as a Factor of Development of Underdeveloped Countries."



President Tito of Yugoslavia in conversation with Sir Harold Hartley during the meeting.

Among representatives of underdeveloped countries were two delegates from Burma. On the right is Ing. Franz Hintermayer of Austria.

developed,[12] and although there can be no hope of calculating exactly the optimum level of energy investment for any particular region, even with the aid of computers, it is certainly possible to make dynamic comparisons between countries[3] and draw general conclusions. After all, as Mr. Sanders pointed out, the factors involved—men, materials, machines, methods and money—were the same everywhere.

Diagnosis

As has been noted, a power survey might be divided into two stages, which in terms of medical analogy may be described as study of the patient, and choice of medicine. The first stage must clearly be a diagnosis, which may conveniently be performed by examining a series of contributory factors, and the present article lists these factors, commenting on each in turn.

Capital Available

In any assessment of this kind the economic facts of the situation ultimately determine the action to be taken, whether the country in question frankly bases its economy on the price system, or exercises some form of central planning. No one can build a power station, or anything else, unless they have access to the right kinds of men and materials, either directly or through the medium of barter. Thus the first consideration must be to discover the amount of capital which the country is able and prepared to devote to power development, or is able to borrow for that purpose. Mr. Gunnar Myrdal has rightly said that profitability cannot be the sole criterion, in tackling the problem of underdeveloped countries, since the yield is not simply in money. Thus investment in power may provide the decisive stimulus that leads a country " to take off into sustained growth,"[1] enabling it to rise by its own efforts. But in general and over a long period the determining factors will be economic since the basic aim—to raise living standards—is essentially an economic impulse.

In making an economic judgment it is necessary to be clear as to what is understood by economic factors. They have been defined as those " which can be expressed in quantitative terms and used to guide the choice between alternative courses of action, with a view to ensuring the most fruitful use of available resources."[13] But on the periphery of economics there are social and political considerations to bear in mind. Nuclear power, for example, is thought to lend prestige to a country.[13] Where administrative authority is weak or immature, there may be a tendency to produce for current consumption rather than to undertake long-term projects, whereas something between the two is desirable. Grandiose partly used schemes tie up capital wastefully,[6, 9] while starving the consumer is likely to reduce the effectiveness of the available working force; " the consumer should not be neglected even for a transitory period."[4] Another motive, which may be political in origin but also has economic virtues, is the desire to be independent as far as possible of market fluctuations, though self-sufficiency is almost certainly unattainable. For this reason young nations seek at an early stage to diversify their production and to minimise their dependence on a single crop.[4] But such a policy does not necessarily imply industrialisation; not only is agriculture a primary activity, since food is indispensable, but it is also extremely varied in its product. It is evident, therefore, that the basic approach to a higher standard of living is to make the most effective use both of indigenous resources,[5] including fertile soil, and of available capital.[14] Without capital accumulation there can be no cumulative growth.

The first and best approach to securing the necessary capital is to raise it within the country where it is required; in Mr. Myrdal's words, the country should be enabled " to lift itself by its own shoestrings."[1] It is possible, he said, by a " policy of frugality " to increase the savings quota from 5 to 10 or 12 per cent. The capital so obtained should be combined with an increase in the proportion of workers engaged on productive work and an improved distribution of labour.[15]

Mr. Edward Kardelj, Vice-President of the Federal Executive Council of Yugoslavia, opening the meeting.

Mr. Walker Lee Cisler (United States).

Capital may be brought in from outside, either through the agency of international organisations, or by negotiations with foreign countries. Ing. C. Milićević, President of the Yugoslav National Committee of the World Power Conference, reported that the International Bank for Reconstruction and Development had already provided credit amounting to 2½ billion dols., a third of which had been devoted to the electricity supply industry. But it was generally believed that loans from international and indeed from all outside sources would be inadequate to meet the needs of large-scale development.[8, 9]

The third approach is to borrow money from private or institutional investors; this may be effected in two ways: by raising loans for domestic enterprise, or by granting concessions to overseas companies; concessionaires may also provide foreign exchange as income for labour and services.[16] But the need to attract funds from outside is to some extent frustrated by the circumstances of investment. Balance of payments problems[18] and shortages of foreign exchange[9] create difficulties; and potential investors are discouraged by insecurity of investment. In underdeveloped countries, which are often characterised by strong nationalistic feeling, large blocks of capital are either controlled by the Government or are extremely sensitive to Government action. Franchise grants, electric-power rate-making, and threats of expropriation or nationalisation are public powers tending to alarm private investors.[17] To lend the necessary confidence, Governments may be called upon to assume responsibility for power investment, which in view of the size of most power projects is probably desirable in any case. Apart from the need to administer integrated schemes on a large scale, the use of State funds to harmonise engineering work may be invaluable; by accelerating those parts of a programme which fall behind, general delays may be avoided.[18]

There are a number of other considerations bearing on the problem of capital requirements. Underdeveloped countries are distinguished by low income, and low-income countries cannot afford to risk large capital sums on projects of uncertain benefit. A high-income country can make a few costly mistakes without serious hardship,[13] but in the early stages of development a poor country would be unwise to undertake a nuclear power programme or a large hydro-electric project unless an adequate load could be guaranteed in advance. Over-industrialisation and over-investment could also be disastrous,[6] providing " the symbol of development rather than the substance."[18] Nevertheless, there are circumstances, in certain parts of India for example, where the capital investment required for a nuclear power station (or hydro-electric project) would be less than for a coal-fired station; since necessary investment in coal-mining machinery and in a new railway line for the transport of fuel could legitimately be added to the cost of the conventional plant.[19]

It will be seen from the foregoing that to calculate the optimum investment in power plant for a given country would be an extremely difficult if not an impossible task. But certain techniques for this purpose have been developed: input-output analysis, linear programming,[9] macro- and micro-analysis, division into kinds and qualities of energy, and multiple regression[13] are statistical and econometric methods discussed in conference papers; while the basis for a comparative approach is provided by papers which analyse the historical growth of countries already developed.[6, 7, 21] Figures given in one paper[22] suggest that the consumption of energy in industry increases faster than industrial production, and from this observation the author deduces a rule of decreasing yield of energy, believing it to be applicable (if allowance is made for change of tempo) to underdeveloped countries. But investment policy can only satisfactorily be determined on the basis of a full case study.

Geographical

Most of the categories into which a power survey can be divided overlap each other. Although a broad distinction may be drawn between economic, demographic and geographic factors,[23] they are too closely interwoven to offer more than a general guide, but even with the greater number of divisions considered here, some overlapping is inevitable. In the present article, geographical factors are regarded as those which define the broad context of a situation, and such items as mineral resources and transport problems, though strictly geographical, will be treated separately.

An underdeveloped area may be classified first in accordance with its position and climate:[24] whether it is located in an arid zone, a humid or sub-tropical zone, or a temperate zone;[25] whether it has access to the sea; and whether it falls within the orbit of an advanced industrial country.[26] An underdeveloped area such as Saskatchewan or Siberia[27] may profit from the advanced stage of development of neighbouring territories. Next it is necessary to consider the general topography of the region: whether it is mountainous,[28] whether there are lakes or rivers, and whether the rivers are short and steep as in Japan[29], or long and passing through many countries[30] as in Africa. Rainfall and the availability of water[9] generally are clearly important considerations, together with catchment area,[31] geological structure, sedimentation and the influence of watersheds.[32] Water is of course an important factor not only in

Mr. E. A. Sackey of Ghana with Sir John Hacking at a reception given by Vice-President Kardelj.

Academician A. V. Vinter (Soviet Union) with M. Alfred Sauvy (France) and Mr. Gail A. Hathaway (United States of America).

the planning of hydro-electric schemes but also for cooling purposes in thermal plants.

Choice of site is also partly determined by geographical factors, though load requirements are of course equally significant. Whether power should be generated near the fuel,[33] near the load or even near cooling water[34] clearly depends on the energy source to be used, but even the location of a hydro-electric plant affords some flexibility. Nuclear power, which employs a highly concentrated fuel, is probably least tied to a particular location. On the other hand, although the sun is said to shine on all alike, plants using solar energy are limited to climates where tropical latitudes are combined with a clear atmosphere.

Energy Resources

(Character and Volume)

Clearly, the first essential for power generation is fuel or its equivalent, and in performing a regional survey it is necessary at an early stage to ascertain the character and volume of the region's energy resources. A country may have access to fossil or fissile fuels, gravitational energy manifested in tidal movement, geothermal heat, or one of the many media through which the sun's energy becomes available. The sun has been described as a vast nuclear reactor with a negligible depreciation factor, and its energy appears not only as radiated heat and light, but also as the potential energy of water resources, as wind power, and as edible or combustible vegetation (which effectively includes coal deposits).

Although the growth of industry in Europe may have been accelerated by the presence of coal deposits in Britain, Germany and France, underdevelopment cannot simply be attributed to lack of natural resources. Thus although the economically advanced countries consume some 70 per cent. of the energy produced in the world, roughly 50 per cent. of the world's coal reserves, 70 per cent. of oil reserves, and 75 per cent. of water power resources are to be found in underdeveloped areas.[4] It follows that the backward countries can be divided into two main classes: those with energy resources and those without. There is, however, an intermediate class overlapping the other two: it comprises regions in which fuel reserves are of poor quality or not easily accessible. If coal (and coke), oil, nuclear fuels, and water power are regarded as the main energy sources, then regions in the third class will possess not only low-grade deposits of these main fuels, but also such unconventional or special resources as wood, peat, dung, geothermal steam, solar energy, vegetable waste, tidal power, thermal energy obtained from sea water by virtue of its change in temperature with depth, oil shale and natural gas.

Countries without indigenous energy resources are necessarily dependent on imported fuel or power, and at present coal and oil represent the fuels most easily transported. Given present carriage and extraction costs and bearing in mind that one ton of fuel oil has the same calorific value as at least 1·5 tons of coal, import prices for oil are substantially lower than for coal of equivalent calorific content. The cost of distribution after delivery at the port is about equal for the two, since the ease with which coal is stored and the cost of tankage for oil is virtually balanced by the facility with which oil is handled.[36] Thus where fuel is to be imported oil is generally preferred, particularly since tractive and small power plants burning oil are considerably more efficient than corresponding coal-burning units. It has been emphasised[36] that oil is best imported as finished products—liquefied petroleum gases (propane and butane), gasoline, kerosine, gasoil or light Diesel oil, marine Diesel oil, and fuel oil—and not as crude oil for refining after delivery.

In terms of calorific value per unit mass or volume, nuclear fuels are incomparable, and are therefore potentially the best importable power source, but as yet the means of using them are not available to most underdeveloped countries. It should be remembered, too, that, as Mr. H. H. Gott of the United Kingdom Atomic Energy Authority has pointed out, in returning irradiated fuels for processing, containers weighing 25 to 50 times the weight of the fuel may be necessary. Nevertheless, in certain parts of the Arctic and other similar regions where the present cost of power is about 17*d.* to 26*d.* per kWh, the use of nuclear fuels and the construction of appropriate plant might be worth considering.[35] Finally energy may in some cases be imported as electric power by way of transmission lines, or even as gas through pipelines. This ideal approach is unfortunately limited to a few areas.

Countries without conventional fuels are sometimes blessed with alternatives or can make use of materials which lie to hand. Resources in arid zones may include solar radiation and wind power, particularly near the coast and on high ground, and small quantities of dessicated vegetable waste. In humid and sub-tropical zones use may be made of small hydro-electric plants, wind power and solar radiation, together with methane obtained from waste organic manner, which may be available in considerable quantities. Organic wastes and animal manure may also serve as sources of methane in temperate zones, where windmills and small hydro-electric plants may again provide intermittent supplies. Micro-centrales (hydro-electric units) have been developed in France, which are capable of generating 100 kW and may be deposited on site with the minimum of installation. Windmills ranging in capacity from a few kW to several hundred have been built and a Danish machine of 200 kW has just been tested. A wind speed of 25 m.p.h. for maximum output is desirable for these applications. Solar plant ranges from small cookers and flat-plate collectors to comparatively large power stations.[35] In the Caucusus area a station has been planned using mirrors carried on 23 concentric tracks. The mirrors concentrate the sun's rays on a boiler, which also revolves in accordance with the sun's movement, and a power output of 750 to 1,000 kW can be obtained. Small steam engines burning peat or wastes may also prove useful.

Almost all low-grade fuels and wastes can be gasified to form producer gas, an enriched water gas, or synthesis gas as required, so that gaseous fuels may be prepared from innumerable agricultural wastes, including sawdust, wood bark, bagasse, peanut shells, husks from cotton seed and rice, corn cobs, coffee grounds, olive refuse, fibres and many other products.[36] One process employed in Algeria involves the controlled decay of such wastes, whereby compost is produced at the same time.[37]

Another unconventional power source is geothermal energy generally obtained as the thermal content of steam. In Iceland a discharge temperature range of 50 to 150 deg. C. is obtained, with pressures of several atmospheres, but usually drilling to considerable depths is necessary. The total discharge of water, which has a relatively high content of dissolved solids, is said to be about 1,500 litres per second. The heat has to be used near the site, though the communal heating system at Reykjavik is supplied from a source 16 km. from the city. The cost of energy so obtained is believed to be about 5 to 10 per cent. of the cost of oil.[38] Peat is used in the Soviet Union and elsewhere as an energy source and may be burned in the steam boilers of medium and large capacity power stations.[39]

Next it is convenient to consider countries in which fuels exist but are inaccessible or of poor quality. All naturally occurring solid fuels, other than bituminous, semi-bituminous and anthracite coals of a relatively low ash content, and of a graded size free from fines, are generally considered to be low grade.[24] They include low-calorific high-ash-content coals (shales and colliery refuse); medium calorific value fuels such as lignite and brown coals; and high-calorific bituminous fines and anthracite duff.

Low-grade fuels can be used in several ways. In central France, for example, a coal with a high ash content which is difficult to wash has proved commercially usable by mining it on a large scale and burning it on the spot in a modern steam plant.[40] In Czechoslavakia a special pulverised-fuel boiler with a two-pass combustion chamber, representing a transition from a dry-bottom to a slag-tap furnace, has been developed for burning fuels with high ash and water content.[41] The effect of using ever decreasing coal sizes on the economy of power production has been calculated in a Spanish paper.[42] Experience on the burning of lignite has been accumulated in France,[43] while in Victoria (Australia) large-scale processes for upgrading high-moisture-content (63 to 70 per cent.) brown coal to a high-class solid fuel have been developed. Methods of using oil

Dr. Homi J. Bhabha of India talking with Mr. Hong Wong of Malaya.

shale, which is a grey dense sedimentary rock containing up to 80 per cent. ash, have been studied in France, where it is burned as pulverised fuel in a boiler,[39] in Sweden[44] and in Israel, where the potential thermal energy of a local shale has been estimated at 1,330,000 Kcal. (5,280,100 B.Th.U.) per ton, giving a cost per unit heat content 60 per cent. that of oil.[45]

Processes for upgrading or using low-grade fuels are generally of two kinds: gasification and artificial bonding or agglutination of fines or weakly caking coals. Gasification is of course a long-established process but the range of utilisable coal has been extended from coal having a volatile content of about 19 per cent. to coal of 36 per cent. volatile content.[46] Investigations in Czechoslovakia have shown that in the gasification of inferior coals it is possible to improve the quality of raw and purified gas, to lower the fuel consumption and formation of phenolic waste water, and to increase the efficiency and throughput of the gas producers.[47]

Coal can often be extracted most conveniently by converting it to gas *in situ* and drawing off the gas through piping. In the U.S.S.R., underground gasification of coal has reached a commercial stage, while in Britain over 50 field trials on two sites are in progress using six different seams of bituminous coal. The process aims to make some form of channel in the coal seam, through which air is blown after the coal is ignited. A producer-gas reaction takes place usually in combination with a water-gas reaction and some distillation of volatiles from the coal. The gas is usually of low calorific value, about 900 Kcal. per cub. metre (100 B.Th.U. per cub. ft.), and transmission costs are so high per heat unit that it is desirable to use the gas on or near the site. An improvement in quality, making transmission by pipeline of commercial value, is possible if tonnage oxygen is produced nearby.[48] Gas costs have been estimated at between 1½*d.* and 3½*d.* per B.Th.U.

Natural gas, which is largely methane, is burnt as fuel in the United States, Italy, Roumania and elsewhere. Use has also been made of the differential pressure between source and mains, which in Roumania ranges from 3 to 150 atmospheres. Machines developed for this purpose in Roumania are termed a jet compressor, a natural-gas turbine and a tornado refrigerator.[49]

By adding a binding agent, coal fines and anthracite duff can be formed into briquettes and so upgraded.[26, 43] Similarly coke suitable for the metallurgical industry can be produced from weakly caking coals by addition of an agglutinant such as coal tar pitch and by a variety of other processes.

Coke suitable for use in blast furnaces has been prepared in Japan from blends containing 50 per cent. of weakly caking coal, 30 per cent. of semi-coke, and 20 per cent. of Bojuntan, a bituminous agglutinant made by heating a mixture of one part of coal (which may be non-caking) with 3 to 7 parts of coal tar to a temperature of from 300 to 350 deg. C. for 3 to 11 hours.[50]

Finally there are the countries where large unexploited energy resources are available. Hydro-electric potential is widespread throughout the world: of Spain's available 9,000 MW capacity[51] for example, only 36·6 per cent. are employed; Austria is using only one-fifth of a potential 4,000 MW[52], India's untapped water power amounts to nearly 40,000 MW,[20] and only 3 per cent. of Yugoslavia's hydro-electric resources are exploited for her own use.[1] Power export programmes are contemplated by both Yugoslavia and Austria. In this connection, the concept of total energy potential of a

Ing. Franz Hintermayer (Austria) speaking to Vice-President Kardelj (Yugoslavia) and Sir Vincent de Ferranti (United Kingdom).

water course may be a useful guide to its exploitation.[53]

Coal resources too are by no means exhausted in many parts of the world; known coal reserves in India, for example, amount to some 110 tons per head of her 380 million population.[20] But it is nevertheless important to conserve stocks and use them to best advantage. Thus 50 years ago 1 kWh was produced from 7 lb. of coal in thermal stations in the U.S., whereas to-day 1 kWh is obtained from 1lb.[4] Many advanced countries have completed intense studies of coal utilisation and the results may be valuable to underdeveloped countries.[54] Nuclear fuels also add much to the potential of underdeveloped countries: apart from the deposits already being worked in Canada, the United States, South Africa and Australia, there are considerable reserves of uranium and thorium in India,[20] Central Africa and elsewhere. In some cases uranium ores have been exchanged for the means of using them, as in Belgium where reactors are being built under American supervision in return for Congo ores.

In a power survey, not only the nature but also the volume of available power resources must be considered.

General Resources

(Character and Volume)

As Sir Harold Hartley and other speakers pointed out, the best prospect for backward countries lies in the exploitation of indigenous resources.[5] Energy is the means by which such resources may be turned to greatest advantage, and it is evident that their nature and abundance must play an important part in any assessment of power needs. Thus, if bauxite deposits are found, cheap local power will be required for the extraction of aluminium. Moreover, an energy deficiency may be remedied by exporting more lavish resources in exchange for fuel. But although modern exploration techniques, from echo sounding to aerial surveying,[5] reveal an increasing number of valuable deposits in the earth's crust, and although advancing technology discovers uses for a greater and greater number of materials,[9] it is inevitable that some countries will remain better provided for than others; an equitable distribution of natural resources is unthinkable. There seem only two solutions to this problem: an increase in the efficiency of communications and transport so that the disposition of resources assumes diminishing importance, or a redistribution of human population. Human labour is itself among the world's most productive—and most mobile—resources, and the answer may be, not to attract labour to areas rich in natural wealth, but to supplement poorly endowed regions with human resourcefulness. Something of the kind has been undertaken in Israel, where communal settlements, *Kibbutzim*, have been established in territories long regarded as intractable and barren.[55]

Dr. G. H. Daniel (U.K.) taking part in a discussion.

Examples of the influence on power requirements exercised by the presence or discovery of natural resources include the development of hydro-electric potential in Western Canada and on the Volta River in Ghana to meet the needs of the aluminium industry, and in Rhodesia for the copper industry. Conversely, the advent of nuclear power has lead to a demand for such materials as zirconium and beryllium; interest in titanium has been created by the high-temperature requirements of gas turbines; and boron has assumed importance as a rocket fuel. A reserve of taconite, which ten years ago might have been valueless, is to-day of considerable significance to the iron and steel industry.[9] Many energy resources have applications other than the production of power; coal for example is a source of chemical products, and water has an enormous range of uses which must be borne in mind when considering power requirements.[10]

Agricultural Potential

The value of fertile soil is frequently underestimated in assessing a nation's resources, but it is in fact so important and so distinct in its energy requirements that it merits a section to itself. As Denmark has demonstrated, an agricultural economy is by no means incompatible with a high standard of living and culture. It was estimated some years ago that 88 per cent. of farm and forest products on a value basis were used as food and 12 per cent. in industry. This 12 per cent. represented one-third of the total industrial raw materials, so that of all primary production, food accounts for roughly 70 per cent.[5] It follows that the part to be played by energy in increasing agricultural production is an important one.

In most underdeveloped countries initial requirements for agricultural areas will be small independent power plants, probably intermitten in operation ; (these will be discussed in a later section), but eventually it will be necessary for economic reasons to establish a district or regional electric network. The problem of rural electrification cannot be treated fully here, but it is evident that distribution represents a significant fraction of power costs to the farmer, and that prices will diminish as load increases. Thus a primary objective must be to make farmer and farm worker electricity minded; such an attitude can to some extent be promoted by domestic electrification.[56] The intensified utilisation of arable land depends largely on mechanisation[56] and mechanisation requires power.[57] Liquid fuels at present form a considerable part of the farmer's power supply but in future even tractors may be electrically propelled, using a trailing cable. Irrigation in most cases depends on a power supply for raising or distributing the water; in Czechoslovakia a large area of land is irrigated by means of high-pressure pumps with sprinklers mounted on 216 self-propelled carriages.[58]

Factors which have contributed to the success of rural electrification in America are as follows: the organisation of rural electric co-operatives; 100 per cent. 35 year federal loans at 2 per cent. interest; enlightened farmers; standardisation of the engineering and construction services; mass construction techniques; systematic study of engineering methods, new materials and equipment; and planned progressive system development, starting from existing power sources, proceeding first to promising areas that can be reached with minimum construction, and extending the network until most rural districts are covered.[59]

Technical Skill

A factor which may condition the choice of power plant or system adopted by a country is the quality and quantity of technical skill available. Technical accomplishment differs from most other resources in that it can be enhanced by education and training. It has been suggested that for underdeveloped countries simpler equipment is desirable,[60] and in most circumstances this is obviously true, but it should be noted that a complex plant requiring vast technical resources to build may be operated by personnel with far less competence; indeed to some extent the greater the skill of the manufacturer the less demand is made on the operator. Thus a shortage of technically qualified people need not preclude the importing of advanced power plants, though the manufacturer should be willing to provide service and necessary maintenance.

Nuclear power has been quoted as requiring the application of integrated engineering techniques of an advanced kind,[2] but there is no evidence to believe that nuclear plants will be any more difficult to operate than conventional plants.[18] One reason for establishing a nuclear industry at an early stage has been given as the need to train personnel for the future, but though reactors specially designed for training are available, it has been emphasised that power reactors are unsuitable for this purpose.[35]

Transport and Distribution

It has already been shown how in some circumstances the cost of transporting fuel can be legitimately added to the power cost, and it is clear that road, rail and other lines of communication are significant factors in drawing up a power development scheme. These considerations must obviously be linked with power and fuel distribution, as electricity, oil or gas. Finally, there is the problem of choosing a transport system when none already exists.

Figures quoted in a Japanese paper give the overall efficiency of steam locomotives as 5·1 per cent., of Diesel locomotives 21·7 to 23·2 per cent., and of electric traction based on hydro-electric power as 57 per cent. But even for electric traction based on thermal sources the overall efficiency is four times that if the same coal were burnt in a locomotive boiler, but rather less than that for Diesel locomotives. The authors of the paper present arguments in favour of adopting electrification for trunk-line operation.[61] Roads offer a more flexible service than rail transport but at higher cost. Marine or canal transport is extremely cheap but obviously limited to waterways.

The cost of transporting power is high. Moving a ton of coal 1,000 miles costs about £7 by rail and over £1 by sea. For oil the cost is approximately £5 per ton of coal equivalent by rail, over £1 by pipeline, and over 10s. by sea. The corresponding figure for natural gas moved by pipeline is over £2. Electricity is not normally transmitted over distances exceeding a few hundred miles, and the cost of sending bulk supplies 500 miles by high-voltage lines is in the region of ½*d.* per kWh; it is less than the cost of transporting the corresponding quantity of coal by rail but more than if it were carried by water.[9] The relative costs of importing coal and oil[34] have been discussed in the section on energy resources, where attention is also drawn to the high calorific

content per unit bulk of nuclear fuels and hence their low transport costs. About 10,000 times the heat can be obtained from a ton of uranium as from a ton of coal, and irradiated elements, though requiring some 25 to 50 times their own weight of shielding, may be carried at a cost of about £300 to £500 per ton no matter how far. For this reason the use of nuclear fuels for isolated plants may be desirable.[35]

The development of transport in an underdeveloped country may trace the following pattern. As a first stage, transportation on a more or less limited scale will be required for research, exploration and the building of power producing plant. In the second stage natural transport facilities such as rivers and seaports will be of ever increasing importance for the carriage of fuel produced, or for the supply of raw materials to industries on power sites, and the removal of their products. Finally an integrated transport system would become necessary.

USEFUL ELECTRICITY CONSUMPTION OF A HIGHLY DEVELOPED AND AN UNDERDEVELOPED COUNTRY (1954)

Branch	Highly developed country			Underdeveloped country		
	10^9 kWh	Per cent.	kWh per inhabitant	10^9 kWh	Per cent.	kWh per inhabitant
Mining	2·09	21·0	237	0·54	43·8	44
Metallurgy	2·04	20·4	232	0·56	45·5	46
Chemistry	1·07	10·7	121	0·01	0·4	0
Engineering	0·90	9·0	102	—	—	—
Building materials	0·85	8·5	96	0·05	3·8	4
Wood, paper	0·40	4·0	45	0·00	0·2	0
Textiles, clothing, footwear	0·56	5·6	63	0·00	0·1	0
Foodstuffs	0·19	1·9	22	0·02	1·8	2
Other industry	0·03	0·3	3	—	—	—
Transport	0·38	3·8	43	0·01	1·0	1
Municipal domestic sector and agriculture	1·48	14·8	168	0·04	3·4	3
Total	9·99	100·0	1,132	1·23	100·0	100

Nature of Power Requirements

Probably the most complex part of a power survey and among the most important is the study of anticipated power requirements.

Dr. Sergei Skvortsov (U.S.S.R.) reading a statement concerning a projected nuclear power station (see Atomic Review, June 21).

Power demands may be divided broadly into four groups: rural, urban, industrial and transport, but each of these includes a wide range of sub-divisions. Thus industrial requirements include not only heating and lighting but power for chemical or metallurgical processing,[3] while agricultural requirements cover such items as irrigation,[62] electric fencing,[24] crop drying,[19] reclamation of saline land,[19] threshing[66] and flashing lights to encourage egg laying.[63] It is noteworthy that one kilowatt of electric power is sufficient to milk 30 cows.[64] Requirements might alternatively be divided according to purpose: heating, lighting, cooking, refrigeration, motive power, process heat and process electricity.[3] Needs also vary with such factors as growing population,[19] differences in latitude,[3] since in the tropics the heating load will generally be small, and such intangibles as habit and prejudice.

Concentration of Power Requirements

Power costs depend both on concentration of requirements and load factor. The ideal situation would be one in which demand was constant and concentrated in a small area near to the power source, since unused capacity would then be a minimum and distribution costs small. In such circumstances nuclear power might be economic. Unfortunately this is seldom the case and load and distribution factors must be estimated.

Possibly the worst conditions would be found in a rural area with a dispersed population, where the principal load was for lighting. Where lighting predominates over power, load factor is necessarily low,[3] and if the distances between homesteads are very great, small or intermittent power sources might be desirable. Rural underdeveloped regions are characterised by low load density (expressed in kWh per sq. km.); and a boundary figure chosen in Italy to distinguish between high and low load density areas is 10,000 kWh per sq. km. In addition, low concentration areas have been defined in which consumption is evenly distributed over the area and not concentrated at one or two points.[65]

Other requirements include district heating,[66, 67, 68] for which low-quality heat is suitable, and general purpose heat and power for isolated settlements.[35] Both of these can be regarded as concentrated demands, as can chemical and metallurgical processing loads, where cheap and abundant power is necessary, probably from hydro-electric sources. In addition, to achieve an economical use of power it may be necessary to establish combined industries. Thus in India the separation of heavy from natural water is coupled with fertiliser production.[58]

Integration of Demands

Energy resources can seldom be isolated and used solely for power production, and before embarking on a power scheme rival demands must be taken into consideration. Thus coal is not only a fuel but a source of numerous chemical products,[47] such as ammonia[69] and methanol,[70] though these make a comparatively small demand on total resources. Nuclear power is associated with the production of radioactive isotopes. Crude oil is broken down into various fuels and other items,[34] and the problem of refinery operation hinges on the ability to balance the different fractions in accordance with demand. But fuel again has the prior claim. In the case of water-control projects, however, hydro-electricity may well take a subsidiary place.

Mr. J. Stanovnik (Yugoslavia) presenting section A general report.

The majority of hydro-electric projects are associated with multi-purpose river-development programmes. In such cases power demands have to be reconciled with irrigation, navigation, flood control, and consumption.[19] Water may also be required for industrial use or even as cooling water for thermal plants. There may also be a conflict of interests, and priority may fall in the following order: 1. consumption, 2. irrigation, 3, power.[30] Some arrangement for allocating costs must also be devised.[71, 72]

Prospect of Growth

Power development in backward countries can be tackled in many ways but two distincs approaches can be recognised. Small power plants, probably burning Diesel fuel, can be introduced to serve isolated communities; subsequently integration can be carried out, preferably according to some prearranged plan. Alternatively, where considerable capital is available, a major project can be undertaken in anticipation of later industrial or urban development. This approach was adopted in Uganda where an industrial township is now growing at Jinja near the site of the Owen Falls Dam. In this case, however, part of the demand already existed and was previously satisfied by small thermal plants. In circumstances of this kind it is necessary to determine the speed, direction and location of growth,[9] as a guide to the size and nature of potential power requirements.

Factors which might be featured in such an assessment include the discovery of mineral deposits, the availability of low-cost labour, the prospect of forming trading estates, and the disposition of lines of communication. Power development is linked with most aspects of a nation's economy, and is usually carried out on a large scale; it follows that planning must generally be a government responsibility.[15]

It is also necessary to forecast what type of industry is likely to arise. Power has a creative effect on industrial growth and may well determine the nature of a country's production, as in Norway, where abundant hydro-electric resources have led to the development of large energy-consuming electro-chemical and electro-thermal industries. In Sweden 40 per cent. of the electricity consumed by industry is used to produce heat or for electrolysis.[6] The Japanese steel industry is said to have been founded on hydro-electric power. There are also secondary effects, as when the demand of a metal plant for cheap power stimulates the growth locally of other industries.[73] It has been suggested that light industries producing consumer goods are the first to develop at an early stage of industrialisation,[7] and to-day there is also the temptation to build secondary industries based on imported raw materials in order to save the import cost of value added during manufacture.[5] The table[15] above may serve as a guide to the energy consumption of different industries in advanced and backwards countries.

Area Integration

The last factor to be considered is the possibility of integrating power schemes over a large area and even among groups of countries. Rivers seldom confine themselves to one country,[19] and in planning a power project on the Upper Nile, say, the effect on its lower reaches must be considered. Norway and the U.S.S.R. are jointly exploiting a river basin,[33] while several international water-power and electricity distribution projects are planned in Europe. These include Yougelexport,[1] Interalpen,[52] and UCPTE (Union pour la Co-ordination de la Production et du Transport de l'Electricité).[64]

Some of the benefits of such international schemes are as follow. Load curves can be flattened over short periods—interconnection of the British and French electricity systems will favour both countries since peak demand occurs at different times on each side of the channel, so that smaller overall capacity of both British and French plant will be required to meet peak loads. Fluctuations in supply over long periods can also be evened out—thus in the future Continental power pool system. Austria will be able to satisfy part of the peak demand, but to make good her deficiency in the winter months part of her summer exports could be exchanged against thermal-energy imports during the winter season. Austria has also concluded a power-exchange agreement with Czechoslovakia, according to which she will feed into that country power produced in the Austrian run-of-river plants during the summer months and will receive thermal power in exchange during the winter period. Switzerland has also[12] frontier power stations which will form a basis for international co-operation.[75]

The problem of international co-operation is much more difficult in the case of isolated countries. Thus Iceland has abundant surplus power but at least at present cannot transmit it directly to her somewhat distant neighbours. Nevertheless, energy can be exported in the form of industrial products such as aluminium, magnesium and caustic soda. Reference

has also been made to a submarine cable from Iceland to Scotland, which recent developments in direct-current transmission have made at least a future possibility.[16]

The ways in which countries may mutually benefit each other by international co-operation have been listed as follows: by the exchange of energy; by the supply of capital needed for power development; by the exchange of manpower; by the exchange of information and experience; by pooling research and development programmes; and by co-ordinating their energy policies.[11] Finally it is reasonable to suppose that interdependence may become so well established that it will be impossible for any one country to pursue private ambitions without the consent of its neighbours.

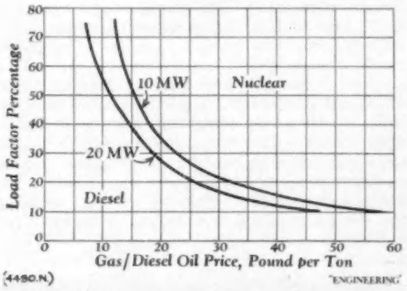
Prescription

Once the survey of a region has been completed, recommendations can be made as to the direction its power development should take. The process of choosing plant and power systems in general can again be divided into several categories, and the following headings represent convenient divisions for such a treatment.

Choice of Energy Source

Based on the results of the survey, a decision can be taken as to the fuel or energy source, or combination of several, which is best suited to the region surveyed. It may be necessary to import fuel or to use unconventional local fuels, but the number of possibilities is enormous, ranging from naphtha and bottled gas to solar and nuclear power. It may even be possible to create resources where none before existed—or rather did not exist in the right place. Thus rainfall may be artificially stimulated to provide reservoirs in locations where they can be of most value. Use of silver iodide generators to cause precipitation is already familiar, and it has been stated that an increase of rainfall of about 11·5 per cent. can be achieved; the cost of the artificially collected water is given as 0·0005 pesetas per cub. metre (0·000024*d.* per cub. ft.).[76]

Choice of fuel in most cases will be determined by cost, of which transport charges may form a major part. The accompanying graph[13] shows



Choice frontiers between Diesel and nuclear fuels in terms of Diesel-oil prices.

"choice frontiers" between Diesel and nuclear fuels in terms of Diesel-oil prices. It indicates which combinations of load factor and fuel-oil prices favour nuclear power and which favour Diesel power. Assuming other factors to be equal, every potential power station site may be represented on this diagram by a point. If the point is above and to the right of the curve for the appropriate power output then a nuclear power station will be more economic; if it is below and to the left of the curve then a Diesel station will be more economic.

Choice of Plant

In many cases choice of plant will be conditioned by choice of fuel, though with oil, for example, the flexibility of refineries permits some freedom in the balance of the fuel fractions obtained. Moreover, some prime movers may be better adapted to certain conditions than other plants burning similar fuels. Thus although its low rating in terms of b.m.e.p. and piston speed compared with high-speed vertical Diesel engines places the horizontal Diesel engine at a disadvantage, its simple and rugged construction combined with good accessibility of working parts may make it preferable in countries where technical skill is in limited supply.

In some circumstances, the small steam plant or gas turbine may offer better service, as where fuels are of low quality. The advantages of the gas turbine may be listed as follows. (1) Maintenance requirements are appreciably lower than those of the equivalent reciprocating engine, and in the present stage of development allowance need be made for not more than one annual shut-down. (2) Gas-turbine installations are light and compact and some types can be run without prepared foundations. (3) Designs are available which can operate entirely without cooling water. (4) Fuels of many kinds and qualities can be burnt, with the further possibility of dual-fuel operation. (5) Considerable quantities of waste heat can be recovered for steam raising. The use of medium-size gas turbines operating in closed cycle with nuclear reactors offers good prospects for the near future where capacities exceeding 5 MW are required.[77] Another prime mover capable of using a variety of fuels is the free-piston engine, which was discussed at the conference by Dr. P. Chambadal of Electricité de France. It has the added advantage that gas is produced at a low temperature so that standard steels can be employed in the turbine.

Reference has already been made to various unconventional forms of plant; but three other systems may be mentioned, two of thermodynamic interest. The heat pump is used for extracting heat from such low-temperature sources as rivers, effluents and cooling water, and raising its temperature sufficiently to meet space-heating requirements. A heat pump can provide either heating or cooling, and can theoretically extract 5 or 6 times as much heat as the power supplied, though the figure is more likely to be about 2·5. At Abidjan on the Ivory Coast a French experimental plant uses the sea temperature difference between the surface and a depth of some 1,300 ft. for power generation. Water at 28 deg. C. taken from the surface is reduced to a sufficiently low pressure for boiling to occur; the steam is then passed through a turbine and thence to a condenser cooled by water at 8 deg. C. drawn from the sea bottom. (An article on this plant is in course of preparation). What might be called lunar or gravitational energy has also been put to use by the French, who have developed an economic tidal power plant. Situated on the Rance estuary near St. Malo it can provide peak power at any time, regardless of tidal conditions, by means of a turbine designed to operate with either inward or outward water flow, combined with a system of water storage. Eventually 38 machines of this kind will be installed at the Rance dam, each of 9 MW capacity, making a total of 342 MW. Another scheme of between 8,000 and 10,000 MW is said to be envisaged for the Bay of Mont St. Michel.

Choice of power plant is not only conditioned by the sources of energy available, but also by the use for which it is required. Nuclear power, except through the medium of electric power, is clearly unsuitable for traction. It is thus important to determine what combination of prime movers is required; base and peak load considerations may call for an integrated power system using nuclear and orthodox thermal plant, nuclear and hydro-electric plant,[18] thermal and hydro-electric plant,[19] or even a combination of hydro-plant,[71] where a wide range of water availability exists. Over-investment in power has already been shown to be undesirable.

Siting

Choice of site will primarily be determined by geographical factors and load considerations. In some cases—tidal or hydro-electric power—geography will have the major influence, and in others—nuclear power and Diesel plants—load will be the determining condition. Presence of fuel or cooling water may also govern the decision. Where the fuel is bulky—coal, for example—and costly to transport, it may be more economic to locate the power plant near the fuel and transmit electric power, though as has already been noted cost of electrical transmission over long distances is also high.

Distribution

The problem of distribution has many possible solutions; not only is it necessary to select a form of distribution—electrical, gas or oil pipeline, rail or sea transport, or even by way of a national hydraulic grid[78]—but the optimum size of transmission system must also be determined. Frequently, a transmission system will not be justified at all.[26] Concentration of load will be a primary factor, and in agricultural areas the choice between small local plants, which are uneconomic, and a distribution network, which is costly,[25] will be difficult to make. The planning of low-density systems requires a special approach.[79] In Sweden 20 kV rural networks have been constructed having a radial form with numerous branches, since it has not proved economic to extend the 40 kV lines.[80] In industrial areas where loads are concentrated, distribution will be a less critical consideration, though to minimise load variation it will be advantageous to link up areas where peak loads occur at different times. The problem of distribution is clearly a complex one, and on its solution may depend the economic margin of operation.

Planning

Finally, it will be necessary to consider overall policy, whether energy should be the concern of local authorities, private industry or Government; and whether an integrated system is justified by the circumstances. The viability of comparatively small independent units has to be balanced against the coherence of central planning.[9, 17] Planning in time must be considered, too: whether it is worth sacrificing current consumption to finance a large project, or better to undertake piecemeal development.[26] In most cases a comprehensive energy policy of some kind will be desirable; otherwise it will be difficult to take advantage of western experience. But, whatever approach is adopted, there can be little doubt that energy will play a major part in the development of backward countries. In the words of Sir Harold Hartley: "Low-cost energy is one of the keys to prosperity."

References

The papers presented at the Eleventh Sectional Meeting of the World Power Conference to which reference is made are listed below. In some cases the comment quoted did not appear in a paper but was made by the author during the discussion. The titles of papers in French, German and Russian are not given, but the groups to which they belong are indicated by code letters as follows: (A) Power as a Factor of Development of Underdeveloped Countries; (B1) Multi-Purpose Utilisation of Water Courses; (B2) Low Grade Solid Fuel as a Source of Power, and The Application of Low Grade Coal in Processing Procedures; (B3) Nuclear Power as a Factor in the Development of Underdeveloped Countries; (B4) Power and Agriculture; and (B5) Power for Metallurgical, Chemical and Allied Industries. Papers unclassified by code letters were presented at the plenary session.

[1] The Problem of Energy in Underdeveloped Countries: Gunnar Myrdal (Executive Secretary, Economic Commission for Europe).
[2] Foreseeable Economic Importance of the Utilisation of Nuclear Energy in Underdeveloped Countries (A.10): Saburo Okita (Japan).
[3] Power Supply and National Production (A.11): R. Y. Sanders (U.K.).
[4] Power as a Factor of Development of Underdeveloped Countries (General Report, Section A): J. Stanovnik (Yugoslavia).
[5] Address by Sir Harold Hartley (U.K.).
[6] Long-Trend Development of Electricity Consumption and Industrial Production in Sweden (A.4): S. Lalander and N. Holmin (Sweden).
[7] Economic Development and Energy Consumption in Japan from 1895 to 1940 (A.34): Koichi Aki (Japan).
[8] The Effects of Social, Economic and Political Factors on Investment in Electric Power: Walker L. Cisler (U.S.A.).
[9] Planning of Investment in Fuel and Power in Underdeveloped Countries (A.15): G. H. Daniel and E. A. G. Robinson (U.K.).

[10] Some Aspects of the Production and Consumption of Energy in the Caribbean and its Effect on the Economy of the Countries Concerned (A.25): J. V. and K. W. Finch (Trinidad).
[11] Integrated Development of Energy Sources in Underdeveloped Areas (A.40): J. A. van den Heuvel (O.E.E.C.).
[12] Paper (A.36) in German: H. F. Mueller and H. Frewer (W. Germany).
[13] Economic Factors Affecting the Establishment of Nuclear Power in Underdeveloped Countries (A.7): J. A. Jukes (U.K.).
[14] Paper (B.1.34) in French: M. Bruni (Italy).
[15] Some Relations Between Industrial Production and Consumption of Energy (A.9): R. Freiberger and F. Schulz (Czechoslovakia).
[16] Economic Aspects of Utilising Surplus Energy Resources in Iceland (A.23): G. Björnsson (Iceland).
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[18] The Multi-purpose Utilisation of Rivers in Japan (B.1.25): T. Nakaoka and T. Hatakeyama (Japan).
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[20] Some General Considerations on Atomic Development in Underdeveloped Areas and the Indian Atomic Energy Programme: H. J. Bhabha (India).
[21] Energy Consumption and Economic Growth in Norway from 1900 to 1939 (A.22): J. Bjerke (Norway).
[22] Paper (A.14) in French: M. de Leener (F.I.P.A.C.E.).
[23] Integrated Utilisation of Resources in Attaining Economic Maturity (A.1): W. A. Dexheimer (U.S.A.).
[24] The Influence of Electrical Power on Agricultural Productivity in Developing Countries (B.4.17): C. A. Cameron Brown and H. R. J. Baigent (U.K.).
[25] The Economic Possibilities of Local Energy Resources to Supply Power for Agriculture in Underdeveloped Areas (B.4.13): E. W. Golding and P. G. Finn-Kelcey (U.K.).
[26] Electric Utility Development and Capital Requirements in Relation to the Economic Conditions of the Province of Saskatchewan in Western Canada (A.26): D. Cass-Beggs and P. Woroby (Canada).
[27] Paper (A.6) in Russian: A. N. Voznesensky and A. A. Beschinsky (U.S.S.R.).
[28] Interconnection of Electric Power Plants in Chile (B.1.14): J. Rittershaussen and D. Santa Maria (Chile).
[29] Efficient Operation of Interconnected Power System for the Utilisation of Hydro Resources in Japan (B.1.28): K. Yamazaki (Japan).
[30] The Integrated Use of Regional Water Resources (A.3): J. K. Hunter and A. W. Pedder (U.K.).
[31] A Theoretical Approach to the Integration of Hydro-Electric and Thermal Power Plants (B.1.10): J. Henderson (U.K.).
[32] Technical Aspects of Planning and Development of Multi-Purpose Water Resources Projects (B.1.1.): D. H. McCoskey (U.S.A.).
[33] Address by Academician: A. Vinter (U.S.S.R.).
[34] The Use of Oil in Developing Countries (A.17): M. E. Hubbard (U.K.).
[35] Nuclear Power Plants for Underdeveloped Countries (B.3.2.): H. S. Arms (U.K.).
[36] Review of the Production of Combustible Gas from Low Grade Solid Fuels and Agricultural Wastes (B.2.7): R. W. Rutherford and F. F. Rixon (U.K.).
[37] Paper (B.2.12) in French: M. Isman (Algeria).
[38] The Possibilities of Using Geothermal Heat for Industrial Purposes in Iceland (B.2.5): B. Lindal (Iceland).
[39] Paper (B.2.16) in Russian: V. A. Golubtsov, P. P. Elizarov, M. A. Mirkin and V. N. Gerasimov (U.S.S.R.).
[40] Paper (B.2.23) in French: M. Therme (France).
[41] Paper (B.2.8) in Russian: B. Limpoukh and O. Vodachek (Czechoslovakia).
[42] Paper (B.2.38) in French: D. F. Fernandez, E. C. Redal, J. R. Santiago and L. N. Garcia (Spain).
[43] Melioration of Low Grade Victorian Brown Coal (B.2.21): W. H. Finlayson and L. A. Crockett (Australia).
[44] The Swedish Shale as Raw Material for Production of Power, Oil and Gas (B.2.3): T. J. Hedbäck (Sweden).
[45] Power Generation by Combustion of Oil Shale (B.2.17): G. Levi, O. Schächter, E. Basevi, E. L. Clark and E. Gottesman (Israel).
[46] Paper (B.2.4) in French: E. Lecutier (Algeria).
[47] Paper (B.2.1) in German: J. Roller (Czechoslovakia).
[48] Underground Gasification in Great Britain (B.2.14): C. A. Masterman (U.K.).
[49] Paper (B.2.18) in German: V. Pimsner, A. C. Vasilescu, and P. Ioanid (Rumania).
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[52] Paper (B.1.22) in German: F. Hintermayer and O. Vas (Austria).
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[57] Mechanisation of Danish Agriculture (B.4.18): K. Hansen (Denmark).
[58] The Automatisation of Large-Acreage Irrigations (B.4.33): V. List (Czechoslovakia).
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[66] Paper (A.12) in German: I. D. Stancescu (Rumania).
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[68] Paper (B.2.19) in Russian: E. Y. Sokolov (U.S.S.R.).
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[70] Production of Synthesis Gas from Low Grade Coal (B.2.26): Soji Terui (Japan).
[71] Paper (B.1.6) in German: J. Hospodář and V. Souček (Czechoslovakia).
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[78] Paper (B.1.24) in French: D. Domingo Diaz-Ambrona (Spain).
[79] Paper (B.4.48) in Russian: Ignati Gostsitski (Poland).
[80] Experience Gained in the Rural Electrification of a Sparsely Populated Region in Northern Sweden (B.4.14): E. Kaijser (Sweden).

10 KW WATER-DRIVEN DIRECT-CURRENT GENERATOR

A Package Unit for Remote Areas

The Food and Agricultural Organisation of the United Nations, in the course of a report on rural electrification, has called attention to the possibilities and advantages of employing small water-power generating sets in remote areas (such as exist in abundance in Turkey, Yugoslavia and India) which are unlikely to be reached by a public supply. From an engineering point of view the development and manufacture of such a "package unit" is not without its problems, as it is essential that tit should be fully reliable and require little or no maintenance.

Standard small water turbines are mostly "tailor-made" to suit specific site conditions. The fall of water and length of pipeline determine the governor characteristics; and as no two sites are identical, in most instances the location must be studied in detail. If the turbine is to drive an alternator its speed must be accurately governed so as to keep the frequency constant; and this often calls for expensive, sometimes complicated, equipment.

The governor must also be designed to control the turbine against the full power of the water fall and a considerable effort is thus required from the governor servo-motor to move the guide vanes. The "package unit," therefore, cannot be produced economically unless the problems connected with governing are very much simplified or altogether removed.

This last solution is the most attractive and is the one adopted in a unit developed by the Armfield Hydraulic Engineering Company, Limited, Ringwood, Hampshire, in co-operation with Lancashire Dynamo and Crypto Limited. The unit, which is illustrated on this page, is ungoverned; the turbine is allowed to operate at any speed between normal and run-away. The speed also falls as the load is applied, and the optimum efficiency is obtained when the output reaches a value of 10 kW.

The water flow at run-away speed is of the order of 65 per cent. of that at full load. This small change in the amount of discharge simplifies the pipeline problems in all cases where a long pipe is required to bring the water from the forebay to the turbine. Furthermore, the absence of a governor makes it possible to use a turbine with fixed guide vanes.

DIRECT-CURRENT GENERATION

The wide range of speeds at which the set operates necessitates the use of a direct-current generator. The voltage of this unit is maintained constant by a regulator irrespective of any changes in load and speed. The result is a simple plant with a maximum of reliability under a variety of operating conditions. In fact, the absence of a governor and the simplicity of this Armfield L.D.C. "Micro-Set" enable it to be produced as a standard unit, which can be readily supplied to any site with an adequate fall of water.

The set illustrated consists of a 16 b.h.p. Francis turbine with a vertical shaft volute case, which is directly coupled to the generator. A voltage regulator is mounted on an adjacent control panel and the unit is completed by an inlet valve. The equipment has been tested under a head of 52·5 ft., but is suitable for falls between 45 and 65 ft. The corresponding water flow range is from 4·2 to 2·8 cusecs. The shaft speed varies between 1,040 r.p.m. to just under 2000 r.p.m. on no load. Although the guide vanes are fixed, they are accurately adjusted either at the makers' works or on site to give the required output of 10 kW under any head within the useful range.

The machine is supported on three legs so that only a sound flat floor with an opening for the draught tube is required. It should, however, be housed in a simple weather-proof hut, which can most economically be manufactured on site from local materials.

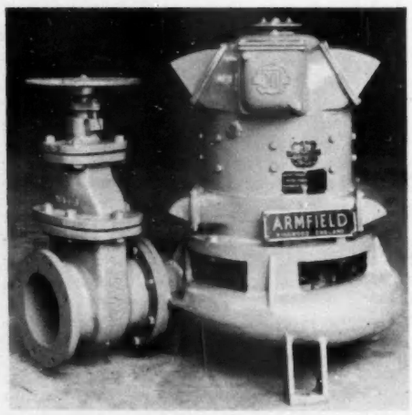
COOLING AND VOLTAGE REGULATION

The generator has a maximum output of 10 kW at 230 volts. The enclosure is drip-proof and the ventilation arrangements have been carefully designed to ensure adequate cooling at the lower speeds without objectionable noise at the higher speeds which are experienced on no-load.

All the connections between the switchboard and the generator are of flexible cable, which is fitted with plugs and sockets ; and the automatic voltage regulator, which is mounted within the switchboard, is similarly arranged so that no skilled wiring is necessary on site.

The voltage regulator is of the carbon-pile type and was manufactured by Newton Brothers (Derby), Limited. The carbon pile is housed in a ceramic tube in which it slides freely, though without undue clearance. The tube itself is a close fit inside a heat dissipator and has high thermal conductivity, which readily permits the heat generated in the pile to be dissipated to the surrounding air. The absence of vibrating contacts in this type of regulator enables the equipment to be used without causing interference with radio installations. The regulator is compensated for temperature to ensure satisfactory operation over a variety of climatic conditions.

Careful thought was given by the makers to the question of output and it was finally decided that 10 kW would cover the majority of cases. This output should be adequate for lighting and heating a house including a standard size electric cooker. It should also prove adequate for the lighting of a small community, or for providing the power required in farming or small local industry.



The Armfield L.D.C. "Micro-Set" is a 10 kW water-power plant driven by a Francis turbine. It is designed to meet the need for electric power in remote or isolated areas.

Marketing

HIDING OUR WARES

Complaints can generally be heard at trade fairs, particularly international ones, that British industry just has no clue how to put its best foot forward. Always, it seems, we are beaten to it by Germans, Americans, even Russians. Intrigued by this criticism, perhaps even stung by it, for they are becoming more industry-conscious every day, Political and Economic Planning (P.E.P.) investigated the whole question. The result, a broadsheet entitled *Trade Fairs and Exhibitions*, is on the whole favourable to those who see in the long succession of trade fairs throughout the world a dangerous drain on their resources: "significantly" they say "criticisms are seldom made by exhibitors or trade buyers, who are perhaps better aware of the commercial issues involved." On the other hand, "the British effort in international fairs is in fact often better than it appears to the outsider."

P.E.P. point out that the primary British aim is sales, "not grandiose displays for purposes of prestige or propaganda." Their survey brings to light no evidence that more frequent or more lavish pavilions would lead to more sales. On the other hand, "national prestige cannot be ignored." P.E.P. suggest there is room for a joint effort by the Government and industry. Greater efforts should be made to encourage more attractive international fairs in this country, either by making the British Industries Fair into an international occasion or by inviting wider foreign participation in specialised fairs. A new exhibition centre is proposed, "with every up-to-date amenity, and in pleasant surroundings." The importance of making every effort in this direction a joint one by government and industry is stressed, for "something that industry does not think worth backing is likely to be predominently uneconomic." Quick action is required. P.E.P.'s analysis of the problem would do much to stimulate it. It is concise, well informed and most stimulating.

★ ★ ★

Two International Fairs, 1958

The German and the Japanese are never slow getting off the mark and are often very good indeed at attracting attention to themselves. The most comprehensive information, attractively presented and giving all the details the British exhibitor could need, was sent to the Press this month for the 1958 Japanese International Trade Fair to be held next April in Osaka.

Described as "the shortest way to the Far Eastern market," the Osaka fair has for its stated objective "to promote international trade, commerce and industry, and contribute to the furtherance of international friendship." Everything is stated simply and clearly, including the location of fair sites, the site facilities available, space rental rates, the procedure for applying for exhibit space, hotels, air services, first class fares to Tokio, etc. Even food, with the surprisingly stark reminder that "rice is the only food item still rationed", and bus services are included. The closing dates for application is November 30 this year.

Another international fair announced recently is the International Fair Print and Paper, DRUPA, to be held in Düsseldorf in May next year. Printing, bookbinding and paper converting machinery will be on show. This is a good example of the international specialised fairs advocated by P.E.P.

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Drab Insularity

Representatives of firms taking part in the Electrical Engineers Exhibition took a whole string of negative decisions last week. The A.S.E.E. show will not become international, "for the time being"; the run of the exhibition will not be extended; the show will not be open to the public on any one of its five days. The organisers of this most successful show will doubtless be disappointed people. Even B.E.A.M.A. will feel frustrated. But this is the will of the majority, and who is to question the wisdom of those who pay for the space concerning who shall exhibit and who shall see their products?

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Where to Look

A survey of the sources of statistical market information available in the United Kingdom has been made by the Market Research Society, and a most useful publication has resulted, under the title *Statistical Sources for Market Research*. Under section headings such as Population and Vital Statistics, Labour and Employment, Raw Materials, Industry, Retail Trade and Distribution, Advertising and Readership, and five others, the Society provides a list of and discusses, the many government, trade association and business publications which can be referred to. The introduction suggests how the work of reference may be organised to provide the required information both quickly and by the most economical methods.

More and more firms are realising that few if any business decisions can be taken without accurate factual data on the market for their products. A great deal of what they need is published, but few know where to look or how to consult the sources that are available. The Society's little book does not aim to be comprehensive, but what is listed is, or should be, the staple diet of market research workers. Sales managers who are suddenly asked to produce sales forecasts can, with a minimum of trouble, gather together most of the information they require. The minimum of those publications which are constantly required for reference, and should therefore be purchased, is listed and described. From this a basic library can be compiled and the rest can either be borrowed from or consulted at libraries. To know where to look is half the battle and as a general guide the Market Research Society's book is unique.

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A B.O.A.C. Survey

A party of B.O.A.C. officials is at present in South America making a survey of the prospects for air services between the United Kingdom and the South American continent. The demise of the Comet forced the Corporation to suspend their regular services to Rio de Janeiro, Montevideo, Buenos Aires and Santiago in April, 1954. Since that date the situation in South America has changed a great deal and the availability of new fast aircraft may well lead to a resumption. The fact-finding team's report should provide information on the development of industry and commerce in these countries, which would be most useful to British exporters. It is to be hoped therefore that at least some of the facts will be published. The industrialisation of some of these countries, particularly Brazil, is gathering momentum and there is a danger that their expansion will take place without British participation. It would be a pity if an improving currency situation should find our exporters unprepared. Selling on the South American continent is not easy, and competition is fierce, but the progress made in the past few months by our European competitors suggests that a great deal more could be done by ourselves. Perhaps a good many manufacturers, particularly those who make capital goods, should follow B.O.A.C.'s example and send fact-finding teams.

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Air Lift

The growth of the air lift to the continent of Europe has surprised even the most optimistic of operators. Bookings have never been higher. Statistics released by Silver City Airways and Air Charter show that this has become a very big business indeed. Last year these two companies ferried over 36,000 and 14,000 cars, respectively, and some 19,000 motor cycles and cycles. This year the traffic has increased between 70 and 100 per cent.

One of the companies, who analyse their car shipments by make, provided evidence that the traffic was by no means restricted to the wealthy owners of luxury cars. Twenty-three per cent. of the cars they carried in 1956 were Fords, 14 per cent. Austins and 10 per cent. Morris. Should the Free Trade Area become a reality and our salesmen take themselves across in strength, another nought could easily be added to to-day's car ferry figures.

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Automation in Marketing

The use of new types of automatic machines and handling equipment in the distribution of petroleum products was the theme of a paper read before the Institute of Petroleum entitled "The Place of Automatic Equipment in Marketing Operations". The author, Mr. Julius Caesar, who is on the staff of Mobil Oil Company, reviews the range of operations which can be performed automatically.

The introduction of automatic techniques for the movement and storage of bulk supplies is reviewed in some detail. For example, the use of automatic dipping mechanisms and valves, in conjunction with remote control systems, takes much drudgery out of the work and reduces costs. It also removes much of the human element from the operation on a tank farm and leads to greater accuracy in blending processes. Mr. Caesar's observations on blending, filling, pumping and delivery suggest that much progress has already been made and that the inevitable expansion of oil storage and distribution facilities will take place at a much reduced labour cost.

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The Americans in India

A recent announcement by the United States company Alco Products Incorporated that among new orders last month were two for 100 locomotives for India and 18 for Pakistan makes sad reading for our own locomotive builders who have for so long been the main suppliers to those two countries. Alco now have 69 locomotives of the "World" class on order from Pakistan railways. These units, typically streamlined, are powered by a 12-cylinder 1,800 b.h.p. Diesel engine and have been especially designed to operate on any of the world's railways. Axle loading is light, and the varied requirements of international clearances are fully met. With only a change in tracks the locomotives can operate on any gauge track, from the one metre found in many countries to the 5 ft. 6 in. gauge used in India, Pakistan, Spain and Argentina.

The large-scale revival of orders for locomotives reported by the company—they have booked this year orders for 248 units valued at £20 million—has been considerably assisted by their ability to provide a standard locomotive at low cost. Some competition for our industry was inevitable, but perhaps it is not too late to put things right and regain a position of pre-eminence built up in a century of successful endeavour.

ATOMIC REVIEW

Safe Keeping

THE concern of those responsible for public safety with the potential hazard of nuclear devices is not unreasonable. Without detailed knowledge of an installation no-one can be sure that some fault or weakness has not been overlooked, and where knowledge is rudimentary the imagination takes command. But as the time since the Calder Hall station began operation grows longer, the public can have less and less cause for anxiety, and eventually they may come to recognise that the concept of built-in safety is no idle claim.

Safety Administration

The Atomic Energy Authority Act 1954 places on the Atomic Energy Authority the duty of ensuring that no ionising radiation from any of their premises or from any waste discharged from their premises shall cause any hurt to any person or damage to any property. The Authority have carried out their responsibilities under this Act through a number of committees dealing with the various aspects of safety policy. These bodies have now been organised in a new structure consisting of two main committees which will be served by a newly formed Safety Branch. As was reported in Atomic Review on May 31, Mr. F. R. Farmer has been appointed Chief Safety Officer to take charge of the Safety Branch.

The Safety Executive Committee has the following terms of reference: (1) to consider the safety policy of the Authority in the design, siting and operation of reactors, process plants and laboratory installations, using the standards recommended by the Health Advisory Committee; (2) to approve for issue by the Authority general codes of practice for design, operation and siting of atomic energy installations; (3) to ratify or criticise recommendations made by staff and specialist sub-committees in relation to specific reactor, process plant or siting proposals and modes of operation and authorise acceptance or rejection of proposals; and (4) to refer to the Reactor Safety Research Committee such items as they consider should be the subject of basic research. The Safety Executive Committee is served by two sub-committees: (*a*) the Reactor Safety Committee which has absorbed the Reactor Location and Reactor Operation Panels of the old Project Health Committee; and (*b*) the Ancillary Establishments Safety Committee which covers all plants and experimental facilities other than reactors. There is an independent Reactor Research Committee acting as a Technical Committee of the Research Group and reporting through common membership to the Reactor Safety Committee. An important part of the functions of the Reactor Safety Committee is to advise on the suitability of sites proposed for nuclear facilities of all sorts including nuclear power stations. The Committee does not direct the choice of sites but gives advice on safety aspects in accordance with the policy defined by the Government in its White Paper on Nuclear Power, Cmd. 9389. The committee is not competent to pass judgment on amenity issues, which are the proper concern of the sponsor, together with local interests, planning authorities and other committees interested in the conservation of our countryside.

The Health Advisory Committee is composed of the chief medical officers and the chief health physicists of the Authority and the Authority's consultants under the chairmanship of the Member for Research. The terms of reference for this committee are: (1) to consider the effects on public and occupational health and safety of the programmes of the Authority and to advise the Executive thereon; (2) to identify research problems on which work is required in relation to the control of health hazards in the development of atomic energy; and (3) to review the medical and health physics work in various establishments of the Authority and to discuss this with medical and biological consultants. This committee defines standards of occupational and non-occupational exposure to radiation and radioactive substances and passes these standards to the Safety Executive Committee for application. It is served by one sub-committee, the Health Panel, composed of the Authority's chief medical officers and chief health physicists.

The newly formed Safety Branch will meet the Authority's need for a permanent staff to serve this committee structure and will operate from the headquarters of the Industrial Group at Risley. The Branch will draw on the resources of all Groups of the Authority for both information and specialised work. It will provide the focus for consideration not only of the Authority's own proposals but also of industrial proposals put to it either directly or through Government departments. It will serve the main committees and sub-committees and will furnish the inspection service which will be needed to ensure the maintenance of safe working within the Authority. It will provide technical advice in the legislative field and draft, with the committees, codes of practice in design and operation. The existence of the Authority's safety organisation will not, of course, affect the assumption of responsibilities by Government departments concerned as soon as the time is proper. It has been developed to enable the Authority to keep under continuous review all factors affecting safety in nuclear development, to advise Government departments concerned with legislation, as well as to advise other users of the Authority's own growing organisation. It will undertake rigorous scrutiny of all proposals for reactors and within the Authority for all other process plants and other laboratory installations capable of introducing hazards.

Insurance

The success of the United Kingdom Atomic Energy Authority in minimising hazard is underlined by a recent authoritative statement that "the risks involved [in operating nuclear reactors] are insurable." A report recently issued by the advisory committee of the British Insurance (Atomic Energy) Committee set up in October, 1955, includes the following recommendation. Maximum cover should be provided to the reactor owner in respect of third party liabilities arising from radioactive contamination, both in respect of damage to property and personal injury. If this principle is adopted—and it seems likely that the entire insurance market (both insurance companies and Lloyd's) will be in favour—members of the public will not need specific cover against such risks.

It is recommended that the entire insurance market should collaborate in the scheme to afford protection, since the sums involved are very considerable—£30 million for material damage to one reactor and possibly a further £10 million arising from reactor operation. Cover for loss of profit seems likely to depend on the capacity of the market to meet it after cover for specified risks has been granted. It is also suggested that a code of safe practice for the operation of reactors should be made legally binding.

At present the U.K.A.E.A. is liable for all claims, but, by providing extensive cover, the new proposals will, give considerable scope for independent enterprise. It should be emphasised that cover is to be extended to atomic installations in all parts of the world, and it is thought that Britain may become in consequence a centre for atomic insurance. Negotiations are said to be already under way for five small reactors in various countries, probably with risks amounting to little more than £1 million, and the market is preparing to undertake the much larger cover necessary for the Central Electricity Authority's plants in three years time. It has been reported that premiums are unlikely to exceed £100,000 even for a £40 million coverage. Risks arising from radioactive isotopes can probably be underwritten through normal channels.

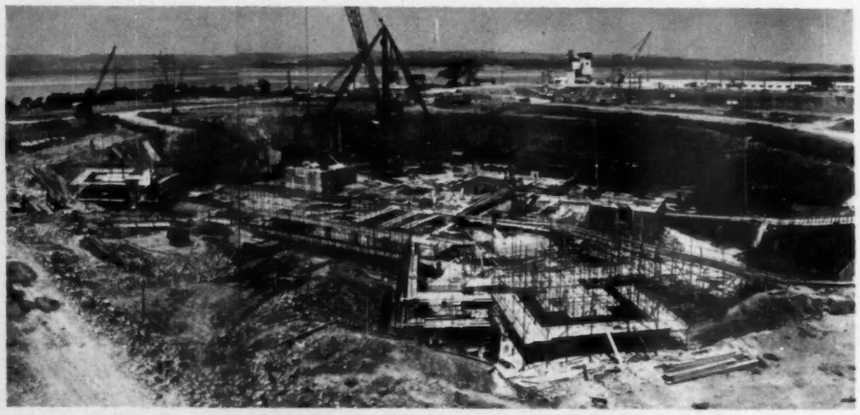
Power and Reactors

Hinkley Site Approved

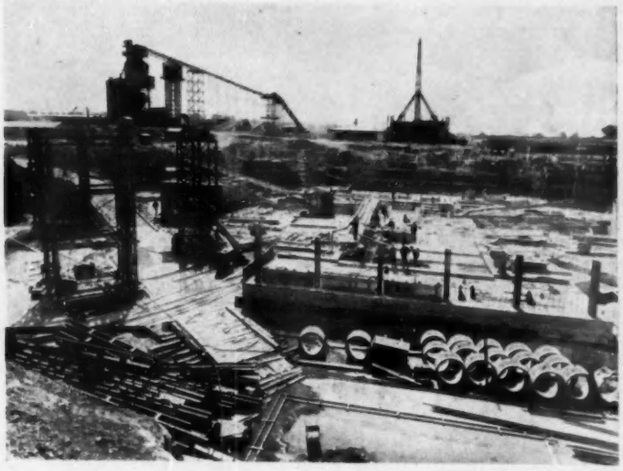
Last week the Minister of Power, Lord Mills, gave his consent for the construction of a nuclear power station at Hinkley Point, Bridgwater Bay, Somerset. Objections to the choice of site had been considered earlier at a public inquiry; alternative sites near Clevedon, Portishead and Watchet had been rejected as unsuitable. This will be the third nuclear power station to be built for the Central Electricity Authority and it is expected to have an initial guaranteed electrical capacity of 450 MW, though, as stated in Atomic Review on June 21, its absolute capacity may be some 500 MW. The two earlier nuclear power stations at Bradwell and Berkeley are to have guaranteed capacities in the region of 300 MW, as is the station proposed for the South of Scotland Electricity Board, for which a site has not yet been approved. It is likely that a second station, also having two reactors, will later be built at Hinkley Point making a total capacity with four reactors approaching 1,000 MW. The station, which is to be undertaken by the group including the English Electric Company, Babcock and Wilcox and Taylor Woodrow, is expected to cost between £60 million and £70 million, and work on the station, which should be in operation by 1959-60, will probably begin in September. To assist in the preservation of local amenities the C.E.A. is to appoint a landscape consultant for the scheme.

Japanese Visit Berkeley

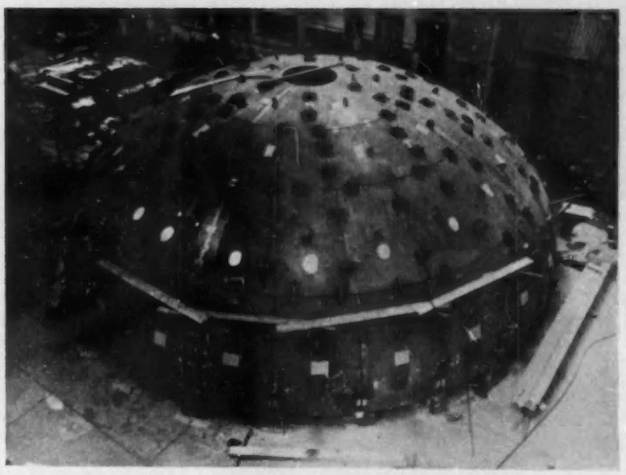
Mr. Koichi Uda visited Berkeley recently to inspect the progress made by the A.E.I.—John Thompson Nuclear Energy Company in building the 275 MW nuclear power station for the Central Electricity Authority. Mr. Uda, who was accompanied by three members of the Japanese House of Representatives and by others from the Japanese Atomic Energy Commission, was said to be much impressed by the building methods adopted. The delegation saw the completed excavations for the two reactors



General view of No. 1 reactor pit for the Berkeley nuclear power station. The crane is shown erecting a large Monotower crane. The indentations on the perimeter of the site marked by U-shaped walls are the locations for the heat exchangers, eight of which will surround each of the two reactors.



Work in progress on the site for the Berkeley nuclear power station, which is being built by the A.E.I.—John Thompson Nuclear Energy Company. The illustration is a view of No. 1 reactor pit with the lower dome of the pressure vessel in the background.



Lower dome of a reactor vessel for one of the Berkeley reactors. The vessel, which will be 3 in. thick and 50 ft. in diameter, is shown inverted on a jig at John Thompson's works. An accuracy to within ¼ in. on the 50 ft. diameter is specified.

and the turbine hall, the work on the concrete foundations and the welding of the first pressure vessel which, when completed, will weigh 1,000 tons. During the visit Mr. Koichi Uda and his delegation visited the headquarters of the A.E.I.—John Thompson Nuclear Energy Company at Radbroke Hall in Cheshire. The company is interested in concluding a satisfactory arrangement with the Japanese. Illustrations on this and the facing page show work in progress on the Berkeley site and the lower dome of a reactor pressure vessel.

Danish Research Reactor

Head Wrightson Processes announce that they have been awarded a contract by the Danish Atomic Energy Commission for the design, engineering, procurement and erection supervision of a materials testing reactor similar to those they are now building for the U.K.A.E.A. at Harwell and Dounreay. It is planned that the reactor will be completed before the end of 1959. These reactors are known generally as PLUTO and their counterpart, DIDO, the most powerful experimental reactor in Western Europe, has now been in operation at Harwell for over six months. PLUTO, like DIDO, is an enriched-uranium heavy-water-moderated reactor with a flux of 10^{14} neutrons per sq.cm per sec. at a thermal output of 10 MW. The Danish PLUTO reactor will enable essential research to be conducted on the testing of materials under the effects of irradiation. The reactor will be erected at the Atomic Research Centre at Riso. Head Wrightson Processes are at the moment engaged on four research reactors (three for the U.K.A.E.A. and one for the Australian Atomic Energy Commission), and this order is their fifth. The contract has the approval of the U.K.A.E.A. who will supply the necessary enriched fuel elements.

High-Temperature Pebble-Bed Reactor

Alco Products, Incorporated, have announced that they are co-operating in designing a nuclear reactor system that will furnish steam at temperatures and pressures meeting the demands of large-scale electrical generating stations. The project is a co-operative undertaking with the New York City construction firm of Sanderson and Porter. The heart of the pebble-bed graphite reactor, a basic form of which was the subject of a note in Atomic Review on June 7, is a collection of parallel tubes filled with small graphite spheres that contain uranium and are heated by uranium fission. Heat is transferred from the spheres to a steam generator by helium gas, which is continuously circulated through the system. The proposed reactor system would generate 50 MW of heat and be capable of producing steam at 1,450 lb. per sq. in at 1,000 deg. F. By achieving such steam pressures and temperatures, advantage can be taken of modern high-pressure steam turbines and electrical generators currently being installed in central electrical generating stations.

Fusion

Controlled Fusion Conference

A private three-day conference on controlled thermonuclear reactions was held at the Atomic Energy Research Establishment, Harwell, from Thursday, June 20, to Saturday, June 22. Delegates included research workers engaged in the United Kingdom and the United States research programmes and about 100 representatives from British industrial firms, universities and interested Government departments. The purpose of the conference was to discuss the progress of both the British and American programmes and to examine some of the practical problems in which it is hoped that British industry might assist. The conference was held on a classified basis and consequently the proceedings of the meeting will not be published.

Private Fusion Research

A "substantial research programme" to study the fusion process has been in progress at Schenectady, N.Y., for more than a year, according to an announcement made last month by Dr. Guy Suits, General Electric vice-president and director of research. Dr. Suits cautioned his audience at the recent International Symposium on Science, Industry, and Education that there has been "too much optimism in some quarters" about fusion power and even pilot-plant production of fusion power would not begin for twenty years. In the meantime, he said, there was a clear role for power production by the first discovered atomic-power process—fission. "My own view," Dr. Suits stated, "is that five additional years of research will be required to make possible a realistic appraisal of the fusion process; in ten years we may be at the point of technical feasibility; pilot-plant production of fusion power will not begin for twenty years; and competitive power production lies beyond that."

Fusion Down to Earth

Dr. P. C. Thonemann, who is engaged on work in connection with thermonuclear fusion at Harwell, has remarked that the fusion-energy content of seawater is rather less than has been suggested in certain reports. A cup-full of seawater is not equivalent to several thousand tons of coal as some may suppose, but to about five cups-fulls of petrol, if the power required for separation of deuterium is taken into account and the energy necessary to initiate the reaction subtracted. Still, there are quite a few cup-fulls of water in the sea.

General Notes

Geneva Conference

It has now been confirmed that the Second International Conference on the Peaceful Uses of Atomic Energy will be held at Geneva from September 1 to 13, 1958. The Advisory Committee has formulated an agenda of wide scope for the conference, and has decided that the procedure for its organisation will be similar to that at the 1955 meetings.

Graphite in Germany

The German company of Krupp is reported to have acquired a 28 per cent. interest in Kropfmühl, the Munich graphite concern. Kropfmühl have been making graphite of nuclear purity for some time.

Course

A course of 18 lectures on "Nuclear Power Engineering" is to be given on Tuesday evenings (from 7 to 9 p.m.) commencing November 12, 1957, at the South East London Technical College, Lewisham-way, London, S.E.4. Section one of the course will be concerned with atomic structure, radioactivity, nuclear structure and nuclear fission. Section two will cover elements of reactor design, including neutron diffusion and related equations, calculations of lattice constants, thermal considerations (reflectors, moderators, shielding and choice of coolant), reactor kinetics (pile running, equations and poisoning), and handling and processing of fuel sources. The final section will be devoted to reactor instrumentation, dealing with neutron-flux measurement, pulse counting channels, shut-down amplifiers and health instruments. Students are expected to have reached a standard equivalent to Higher National Certificate in engineering or physics. The London fee for the course is £1 10s. Applications should be made before September 16, and if made by post should give not only the intending student's name and address but also his employers'.

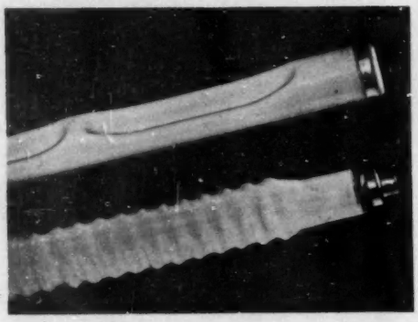
In Error

Last week in our survey of Swedish atomic energy developments the name of the Swedish Atomic Energy Company was given incorrectly; the correct title is A.B. Atomenergi. A.B. stands for Aktiebolaget and corresponds to "Limited Company." In addition, on page 733 of our issue of June 7, we referred to the rating of the AGN-201 reactor, made by Aerojet-General Nucleonics, of San Ramon, California, as 100 MW. The reactor is of course intended primarily for training purposes and the figure should have been 100 mW (100 milliwatts), as given in Atomic Review last March 1.

BRIGHTER FLUORESCENT LAMPS

The quantum efficiency of phosphors used in present-day fluorescent tubes has now reached close to 90 per cent. of its theoretical maximum value. Development work on fluorescent tubes on both sides of the Atlantic is now being aimed at producing a more concentrated light source by increasing the power dissipation per unit length of discharge.

Until recently the British 5 ft. 80 watt lamp was the most heavily loaded in the world. Increasing the loading still further resulted in a



By the adoption of shapes such as these, fluorescent tubes can be operated at much higher loadings.

lowering of efficiency owing to the rise in mercury vapour pressure that accompanies the rise in temperature. By making the tube kidney-shaped or ellipsoidal in section over most of its length, however, a lower concentration of positive ions can be achieved. This gives a corresponding increase in the electron energy. The process is helped by reducing the filling pressure of the carrier gas, argon, enabling increased electrical loading to be achieved with good efficiency. Lamps 4 ft. long, dissipating 100 watts, have been developed along these lines. Two such lamps, shown in the illustration, were displayed by the General Electric Company, Limited, Magnet Home, Kingsway, London, W.C.2, at the exhibition that accompanied the recent British Electrical Power Convention at Eastbourne.

The greater part of the exhibition was given to domestic equipment, and supplemented in a valuable way the lecture session devoted to electricity in the home. Among the exhibits was a radiant heater produced by the Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17. As radiant heat does not heat the intervening air but only the objects or persons on which it is directed, the heater can be adopted economically for exposed situations as well as for normal indoor use in factories, offices, shops, etc.

The chief parts of the unit are the aluminium reflector and the tubular metal sheathed heating element. The latter is constructed by inserting a magnesium tube into an outer sheath of a non-scaling non-corrodible alloy and introducing within the magnesium tube a helical coil of heat resistant wire. The magnesium is then wholly converted into solidly packed magnesium oxide. In this way centralisation of the spiral is ensured, and an even thickness of insulation between spiral and sheath achieved. The element ends have weather proof seals with screwed terminals, and are themselves sealed into the terminal box with silicone rubber bushes.

Irradiated polythene as a cable material possesses several advantages over normal polythene—better temperature stability, insolubility in mineral oils, better electrical characteristics. Wandleside Cable Works Limited, Wandsworth, London, S.W.18, were displaying cables using this material. Their method of production is interesting in that a radioactive isotope is used as a radiation source instead of a linear accelerator.

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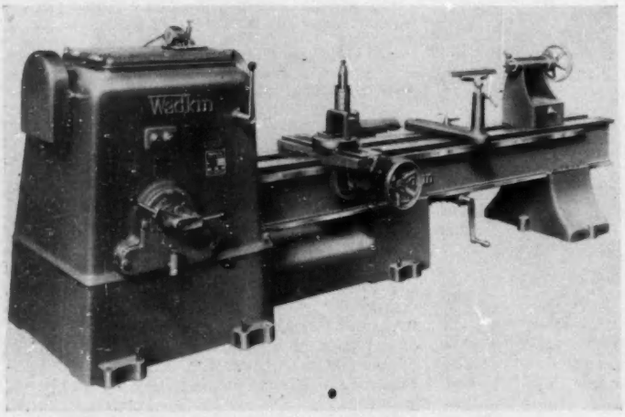
SOCIETY OF CHEMICAL INDUSTRY

Mr. W. E. Dick has been appointed editor of *Chemistry and Industry*, the weekly news organ of the Society of Chemical Industry. Mr. Dick, who was for many years editor of *Discovery*, will succeed the present editor, Mrs. Bush, on her retirement at the end of June.

HEAVY DUTY WOOD-TURNING LATHE

A new addition to the range of woodworking machinery made by Wadkin, Limited, Green-lane, Leicester, is illustrated herewith. It is a heavy-duty lathe for wood turning, and is being built with 12, 15 or 18 in. diameter centres. The bed is arranged with a sliding motion controlled by a rack and pinion, thus providing a gap of adjustable width for faceplate work up to 5 ft. diameter. All the machines take up to 8 ft. 3 in. between centres with the gap closed.

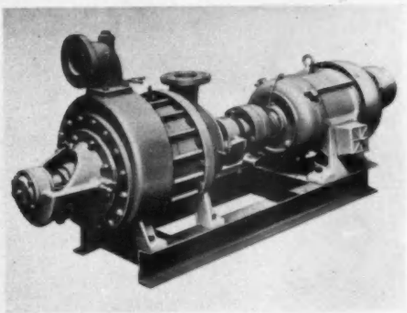


The Wadkin heavy-duty wood-turning lathe is made in three centre sizes, all with a gap bed for large faceplate work.

The lathe spindle, which is mounted on Timken taper roller bearings, is prepared at each end to receive a flange-mounted faceplate, and is bored at the front end for Morse taper centres. It is driven by a motor in the headstock through a nine-speed gearbox and multiple V-belts. Speeds, which range from 100 to 1,900 r.p.m., are selected by means of levers mounted on the front of the headstock.

There is a powerful brake, operation of which automatically switches off the driving motor, and a spindle lock to facilitate setting; this is interlocked with the driving motor. A taper of the same size as that in the headstock spindle is provided in the tailstock, which can be set over for taper turning.

A compound tool slide can be provided, with hand controls, and a tool post of normal lathe type. For outside turning there is either a tripod stand with a hand tool rest, or, for larger diameter work, an independent travelling carriage mounted on a base, with rack and pinion movement, cross traverse, and central rotating movement.



Available in from 2 to 6 stage designs, this Pegson pump is designed for high-head duties.

MULTI-STAGE PUMP FOR HIGH PRESSURE HEADS

A new series of 4 in. pumps introduced by Pegson, Limited, Coalville, Leicestershire, is specially designed for applications where high pressure-head duties are required, such as mine pumping, water-main boosting and boiler feeding. The pump is available with 2, 3, 4, 5 or 6 stages, the outputs ranging up to 500 gallons per minute on a 10 ft. dynamic suction lift. The maximum head is 520 ft. Positive automatic priming on suction lifts down to 25 ft. is ensured by the design of the pump. All the pumps in the range, which will handle liquids containing up to 25 per cent. suspended matter and full solids up to $\frac{1}{16}$ in. overall size, can be supplied with engine or electric motor drive. Alternatively, the pumps can be provided with bare shaft extensions for driving from an existing power source.

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NOTICES OF MEETINGS

Institution of Mechanical Engineers

CAMBRIDGE
Summer Meeting, Tues., July 9, to Fri., July 12. Addresses, on "Engineering Education at Cambridge," by Professor J. F. Baker; and on "Some Contributions to Mechanical Engineering by Cambridge Men," by G. B. R. Feilden. The Guildhall, Cambridge. Wed., July 10, 10.30 a.m.

LUTON
AUTOMOBILE DIVISION Summer Meeting, Thurs., July 11. Two short addresses by representatives of local industry and a works visit.

Institution of Naval Architects

BRISTOL
Summer Meeting. Tues., July 9, to Thurs., July 11.

Physical Society

SOUTHAMPTON
OPTICAL GROUP Summer Meeting, Mon. and Tues., July 8 and 9.
Opening Address, by Professor A. M. Taylor; "Devices for the Measurement of Optical Phase Differences," by H. G. Jerrard; and "On Spectrophotometric Measurements of Free Radicals Produced Photochemically," by Dr. M. C. K. Symons, at 2 p.m. "The Photoelectric Recording of Interference Fringes," by Dr. E. V. Vernon; "Measurements of the Faraday Magneto-Optical Rotation," by Professor A. M. Taylor; and "Problems of Measuring Phase and Size Simultaneously in a Microscope," by Professor E. Ingelstam, at 4.15 p.m. The University, Southampton. Mon., July 8.
"Artificial Birefringence in Solids," by Dr. J. E. Braybon; "The Theory and Techniques of Micro-Wave Spectroscopy as Compared with Those in the Visible Region," by Dr. J. E. Ingram; "Birefringence in Flowing Liquids," by H. G. Jerrard; and "On Tilton's Vitron Theory of the Structure of Glass," by Dr. W. S. Rodney, at 9.30 a.m. "Precision Measurements of Refractive Index by Means of a Birefringent Shearing Interferometer," by Professor E. Ingelstam, at 2 p.m. The University, Southampton. Tues., July 9.

Plastics Institute

LONDON
Annual General Meeting. Gallery Conference Room, National Hall, Olympia, W.14. Fri., July 19, 12 noon.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Naval Architects, 10 Upper Belgrave-street, London, S.W.1. (SLOane 4622.)
Physical Society, 1 Lowther-gardens, South Kensington, London, S.W.7. (KENsington 0048.)
Plastics Intitute, 6 Mandeville-place, London, W.1. (WELbeck 5439.)

In Parliament

RAILWAY SPEEDS AND SAFETY RISKS

Problems concerning the travelling of railway trains at high speed were raised in the House of Commons last week. Mr. Hector Hughes (Labour) pressed Mr. Harold Watkinson, the Minister of Transport and Civil Aviation, to make a statement on the experience of his accident inspectors regarding the most economical way of running railway trains from the accident point of view. He wanted to know about the degree of increased accident risk caused by running trains at high speeds, compared with their operation at low speeds, and asked what the ratio was between speed and the risk of accidents.

Mr. Watkinson said that the experience of the Inspecting Officers of Railways did not suggest that there was a direct relationship between speed and accident risks on the railways. This position was due no doubt to the manner in which railway engineers and operators, who traditionally demanded wide margins of safety, met requirements for higher speeds by raising their standards of construction, maintenance and operation. A further reason for the existing state of affairs undoubtedly lay in the way in which the operating staffs responded to higher speeds by showing increased alertness.

HEAT EFFECTS ON RAILWAY RAILS

Another aspect of railway safety raised by Mr. Hughes was how many railway accidents during the past 20 years had been found to have been caused by heat buckling the rails, or otherwise impairing the permanent way or rolling stock. He also asked how many of these accidents were caused or contributed to by the high speeds of the trains. Mr. Watkinson stated that five serious railway accidents during the past 20 years had been caused by the heat of the day. All were due to train derailments caused by the distortion of the rails. The accidents concerned were those at Bletchley, Wath Road, Merstham Quarry Tunnel, Tollerton, and Abington. In them, eight persons were killed and 135 were injured. Speed contributed to these calamities in the sense that the accidents might not have occurred if the trains had been travelling very slowly.

REDUNDANCY AT GOVERNMENT FACTORIES

A number of matters relating to redundancy at Government establishments were raised by Mr. S. T. Swingler (Labour). In reply, Mr. Iain Macleod, the Minister of Labour and National Service, said that the arrangements for consultation with his Department when redundancy was likely to arise covered both Government establishments and the factories of firms engaged on defence work. He received as long a notice as could possibly be given. In all cases, labour considerations, including the level of unemployment in the neighbourhood, were taken into account, although, of course, these considerations might not always prevail.

So far as redundancies at the Royal Ordnance Factories at Radway Green and Swynnerton were concerned, Mr. Macleod said that, some time before any decisions had been taken regarding the excess labour force at these establishments, he had been informed that it would probably be necessary to reduce the numbers of employees at these factories during the current year. Some three weeks before the earliest discharges took effect, representatives from the local offices of the Ministry of Labour attended at the factories to register those persons who needed assistance in finding other employment. At Radway Green, 23 men had been placed in employment and the applications of nearly 70 more had been submitted to other employers, in spite of the fact that their discharges did not become effective until the end of June. Of the 190 part-time workers at Swynnerton who had registered for other employment, 32 had already been placed in full-time work. Proposals for the conversion of these factories to civil production, in order to find other employment for the workpeople rendered redundant, had been carefully investigated by the President of the Board of Trade, the Ministry of Supply and other members of the Government.

BETTER CONDITIONS IN SHOPS AND OFFICES

Pressure was brought to bear by the Labour Party on the Government for a greater implementation of the various proposals of the Gowers Committee. Mr. Alfred Robens (Labour) moved, on behalf of the Opposition, that the Government be called upon to carry out " in full and without delay " the recommendations of the Committee of Inquiry into the Health, Welfare and Safety in Non-Industrial Employment and Hours Employment of Juveniles (Cmd. 7664, 1949) and the Report on Closing Hours of Shops (Cmd. 7105, 1947).

He said that the Gowers reports dealt with the health, welfare, safety and protection of 12 million working people, of whom at least 1¾ millions were juveniles. They covered all employees not included under existing protective legislation: persons engaged in shops and offices, hotels, restaurants, indoor and outdoor entertainment, rail and road transport, agriculture, fishing, shipping and domestic service. Since the Committee had reported in 1949, Ministers had stated on many occasions that it was the Government's policy to introduce legislation to carry out the recommendations of the reports. It could not now be said that there had not been adequate consultations with the interested organisations, because about 76 trade and cognate associations had been consulted by the Government. One of the excuses put forward by the Government for not bringing in legislation was that consultation had been a long job. The Government was wanting the help of the Trades Union Congress and they received it. But how much longer did the Government think that they would get the co-operation of the organised workers of Britain, when, on a non-political matter like the health, welfare, safety and protection of workpeople in their daily occupations, they refused to find time for a measure to implement the Gowers Committee's reports?

MUCH ALREADY ACHIEVED

Speaking on behalf of the Government, Mr. R. A. Butler, the Home Secretary, stressed the fact that a great deal had already been accomplished by the present administration. The three props of the existing industrial welfare legislation were the Factories Act, 1937; the Mines and Quarries Act, 1954; and the Agricultural Safety, Health and Welfare Provisions Act, 1956. Each of these Acts had been passed by a Conservative Government. They followed up, and in some ways they went beyond, certain of the recommendations of the Gowers Committee. Progress was being made with the regulations relating to these measures. The Labour Government had had the report on the closing hours of shops before them for four and a half years, without taking any action to implement its recommendations.

After dealing at some length with the Shops Bill, which he described as a tidying-up measure of intense complexity and not a revolutionary measure of social reform, Mr. Butler said that few employers to-day were blind to the problems of the health and comfort of their workpeople. Where the employers failed, as some undoubtedly did, it was not because they did not care, but because their working places were in old buildings with a limited life. Turning to conditions on the railways, he pointed out that the progressive policy of the British Transport Commission had resulted in a considerable improvement in the working conditions on the railways in recent years. Existing installations had been improved and, in new installations, staff premises of a very high standard would be provided. Annual expenditure on welfare on the railways, amounting to about £1½ million from 1951 to 1954, had risen to £1,900,000 in 1955 and to more than £3 million in 1956. Expenditure was expected to be maintained at that level during the next five years.

A number of speakers on both sides of the House took part in the ensuing debate. Mr. Robert Carr, Parliamentary Secretary to the Ministry of Labour, who wound up, said that there would always be scope for further improvements in working conditions. What had been achieved gave no ground for complacency and the Government had no complacency regarding what remained to be accomplished.

REPRESENTATION AT OVERSEAS FAIRS

The Government were asked by Mr. Sydney Irving (Labour/Co-operative) to consider the setting up of an executive body, representative of both the Government and industry, to encourage and finance British pavilions at overseas trade fairs organised on a national basis, and national displays at general trade fairs. He drew the attention of the President of the Board of Trade to the fact that all other Western European countries, as well as the United States and Russia, had such organisations, and that these matters involved questions of national prestige as well as of sales promotion. In reply, Mr. Derek Walker-Smith, Minister of State to the Board of Trade, said that the Exhibitions Advisory Committee had been reviewing present practice and policy on overseas trade fairs, and that its report was expected shortly. The various matters referred to would be borne in mind when the report was received.

CRYSTAL PALACE TRADE FAIR?

Proposals that an international trade fair should be set up in Britain, as a result of the possibility of freer trade in Europe and the fiercer competition regarding British goods, was put forward by Mr. Sydney Irving. He pointed out that there had been many unfavourable comparisons between the British Industries Fair and the international fairs held on the Continent. What requests, he asked, had the Board of Trade received for assistance to enable the Crystal Palace site to be developed as an exhibition centre? Mr. Derek Walker-Smith said that representatives of the Birmingham Chamber of Commerce had raised this question and were to have an interview with the President of the Board of Trade shortly. No actual requests concerning the Crystal Palace site had been received. There were many claims on Britain's investment resources, Mr. Walker-Smith added, and he was not satisfied, at any rate at present, that industry attached such importance to the proposal for an international fair as to justify its having priority.

Engineering Troubles on Conway Bridge

Answering Mr. Peter Thomas (Conservative), who wanted to know the reason for the delays in the completion of Conway Bridge, Mr. Harold Watkinson said that this bridge was expected to be finished by the end of 1958. The delay had been caused by engineering difficulties, which could not have been foreseen, in obtaining satisfactory foundations for the bridge structure.

Rural Water Supplies

From time to time, water supply difficulties in particular areas are brought to the attention of the House. During the past week, Sir Charles Taylor (Conservative) asked about the latest position concerning water supplies for the north-western parishes of the Hailsham Rural District Council. He stressed the urgency of the matter on health grounds and for agricultural reasons. Mr. J. R. Bevins, the Parliamentary Secretary to the Ministry of Housing and Local Government, stated that ministerial approval to the Hailsham scheme had been given on May 6. The Eastbourne Waterworks Company, which was to carry out the work, was now engaged in preliminary operations, but the whole contract was expected to take rather more than two years.

THE HUMAN ELEMENT

Mining as a Profession

An interesting review of the activities of the Association of Mining Electrical and Mechanical Engineers, and of the achievements of their members in the coal-mining industry, is contained in this year's presidential address, "Men, Materials and Machines," by Mr. J. E. Ridley. The suggestion is made that the Association should take steps to increase attendance at branch meetings. During the past three years only a 15 per cent. attendance has been averaged for ordinary meetings, to hear the reading of technical papers. Large gatherings were limited to social occasions, "particularly at dinners when ladies are present."

Mr. Ridley deplores this state of affairs and suggests various practical steps that might be taken to increase both attendance at technical meetings and the Association's membership. First, it is "up to the members to produce papers that will excite interest, stimulate attendance and provoke animated discussion"; second, those who do not attend regularly should be asked for suggestions to improve attendance at meetings. Lastly, a determined drive should be made to recruit among the young.

The Association's membership is almost 5,000, although engineers employed by the National Coal Board numbered 30,000 even in 1952; in addition, there are professional engineers in allied manufacturing industries, colleges, etc. Among new members, electrical engineers heavily outnumber the mechanical. This may be partly due to the Association's foundation by electrical engineers in 1909. Mr. Ridley suggests, to catch them young, the Council should consider "the preparation of a pamphlet explaining in simple language the purpose of our Association, which could be handed out to youths at the beginning of their apprenticeships." Mr. Ridley also discussed the functions of the professional engineer in the mines, and his necessary qualifications.

Jobs for the Young

Universal education has been taken for granted for many years. Only recently has it been realised that the chance for the average boy or girl to take advantage of knowledge and training is woefully limited by the circumscribed outlook of parents and those who make the average child's environment. Youthful square pegs get into round holes all too easily.

A booklet called *Directory of Opportunities for School Leavers* has now been issued which will be available to school-leavers this summer. Thirty thousand copies are going to schools over the next few weeks. This directory has been prepared with the assistance of the Careers Committee of the Incorporated Association of Headmasters and the Public Schools Appointments Bureau. A preface has been contributed by Sir John Wolfenden, Vice-Chancellor of Reading University.

This should meet a long-standing need. Along with a directory for graduates (already issued) and one for "qualified men" (still to come) it forms a useful trilogy to help put men and women in suitable employment. It should help to cut down the serious waste which arises from youngsters going into dead-end jobs and into careers where ill-conceived romance or plain mis-information has trapped them.

Co-ownership in the Copper Belt

A scheme designed to provide an incentive for their more senior employees to become shareholders was announced last week by the Rhodesian Selection Trust group of companies. Under the provisions of this scheme—the Employers' Share Purchase Plan, full details of which have not yet been announced—all those earning above a stipulated minimum will be entitled to subscribe up to a fixed proportion of their wages each month towards the purchase of shares in the open market. Their contributions will be matched to the extent of 50 per cent. by the employing companies, and provisions have been made to safeguard the employees' own contributions. About 3,500 Europeans and 500 Africans are eligible to participate in the scheme.

The need to promote company allegiance and loyalty in the difficult operating conditions that prevail in the copper belt has been felt for some years. But the amount involved is unlikely to be very large. In the case of each of the companies quoted—Rhodesian Selection Trust and Roan Antelope—the total cost is not expected to exceed £80,000 a year, amounting to half the investment represented by the purchases. R.S.T. have an issued capital of £11·3 million and and Roan Antelope's totals £16·1 million. It will be a long time therefore before any company-assisted purchase of shares creates an important employee holding.

Firemen in Conference

Last week's annual conference of the Fire Brigades' Union held at Bournemouth was a triumph for the executive. The strength of the support enjoyed by the union's president, Mr. John Burns, and its general secretary, Mr. John Horner, was underlined by the ease with which they disposed of challenging attacks. There were motions of no confidence in the executive, demands for an impartial inquiry into the state of the union, and an attempt to reinstate an official who had recently offended the executive and been expelled.

All or nearly all the fireworks were let off at a private session, when the critics were duly routed. The only sign of the seriousness of the differences between the executive and their attackers was an attempt made by a Blackpool delegate to have the union's St. Helen's secretary, Mr. A. Curran, admitted to the conference to explain himself concerning his suspension. Mr. Curran had offended by allegedly conducting an anti-Communist campaign within the union. The attempt failed, and all other contentious matters were referred to a private meeting. Mr. John Horner spoke for over an hour and succeeded in disposing of all hostile motions. Mr. Horner's report, which dealt *inter alia* with the resignation of the assistant general secretary, Mr. J. Grahl, and legal action contemplated against the *Daily Mail*, was adopted by 186 votes to 3. The fires were damped, but were they put out?

Communists at the Helm

The presence of members of the Communist Party in key positions within the Confederation of Shipbuilding and Engineering Unions has been denounced by Mr. J. Cooper, president of the National Union of General and Municipal Workers. Speaking at their annual conference last week, Mr. Cooper said that Communist influence, both at workshop level and at the highest stage of negotiation within the Confederation, had led to a most serious situation. Deep divisions exist within the trade union movement, which could affect its future and seriously prejudice the well-being of the country. On the one hand, he said, there were trade union leaders endeavouring to smooth over difficulties and on the other men who did all they could to stir up industrial strife. Mr. Cooper, a member of the Labour Party Executive, considers that the union officer should play a much bigger part in handling problems on the shop floor as they arise, and give guidance to members in the shop.

That there is a strong case for a thorough overhaul of union organisation few will seriously question. The whole edifice, and not only the Confederation attacked by Mr. Cooper, creaks and groans like a tree caught in a flood. But cold water gently squirted by Mr. Cooper on the Jack Committee's proposals for an authorised body to direct wages policy suggests that, he, like most of his colleagues, remains intent on preserving bargaining power at all costs.

Partnership and the Worker

A pamphlet called "Partnership and the Ideal Workman," by Mr. J. Ward Daw has been issued by the Industrial Co-partnership Association. It is in some ways a strange document. It deals with the advantages of profit-sharing and joint consultation and insists on the importance of security for the working man and the importance of a sense of belonging to a group.

But the main plea is for an appreciation of the idea of partnership in industry. Towards the end it says: "In this endeavour to win the co-operation of the workers we are not playing with theories, or philosophies, or even with religion. We are face to face with the stark realities of human relationships . . ." Many will wonder what is left to face the stark realities with if the three categories above are excluded. The idea perhaps is in an earlier sentence. "Partners sink and swim together." This is tender stuff to expose at the next meeting with the shop stewards. No one will deny the value of the idea of partnership if it can be inculcated in a factory or office but it is a plant which has to be nurtured slowly and in due course exposed to the storms of management-labour relations—and it is well that it should. If the partners are to swim together it is no bad thing to have the wages office on the shore waiting for them with more in the packets than the basic wage and a tag line about a deed well done.

Sausages and Incentives

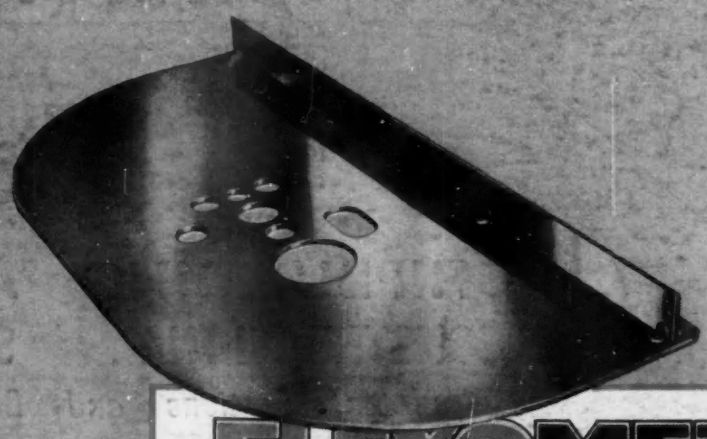
With so many facts and figures these days to prove how efficient the Germans are in the export market and what a beating they are going to give their competitors soon in the European Common Market and the Free Trade Area, it is comforting to think how much the German Juggernaut may owe to the German sausage. Such seems to be the case to judge from a report in a contemporary newspaper about the jeopardy which threatens the German second breakfast (*Zweites Frühstück*) which, by tradition, consists of sausage sandwiches.

A German court of law has ruled that the second breakfast does not exist in law. It all started apparently because some unwise employee in a government office tried to get his ten-thirty snack on his expenses. The court says that there are only three meals a day—which is a somewhat Teutonic way of looking at things. But if this attitude is allowed to spread, it could clearly work fearful havoc in the German industrial system. Courts of law which lay down how many meals there are to a day can soon produce a whole industrial code of what is and what is not legal, which may appeal to the tidy German mind, but which must surely add little to anyone's efficiency—and a great deal to exasperation.

Perhaps the Germans have not worked like ants (or is it beavers?) in the past, but are certainly going to do so now. If they do they should be fairly easy to cope with. The working man who takes his jellied eels or his Yorkshire pudding when he wants them can hold his own with the regimented trenchermen of the Ruhr.

ENGINEERING

An Illustrated Weekly Journal



Flexometal shaped panel for laundry machine, faced with aluminium and sealed at the edges.

By Courtesy of Brown & Green of Luton.

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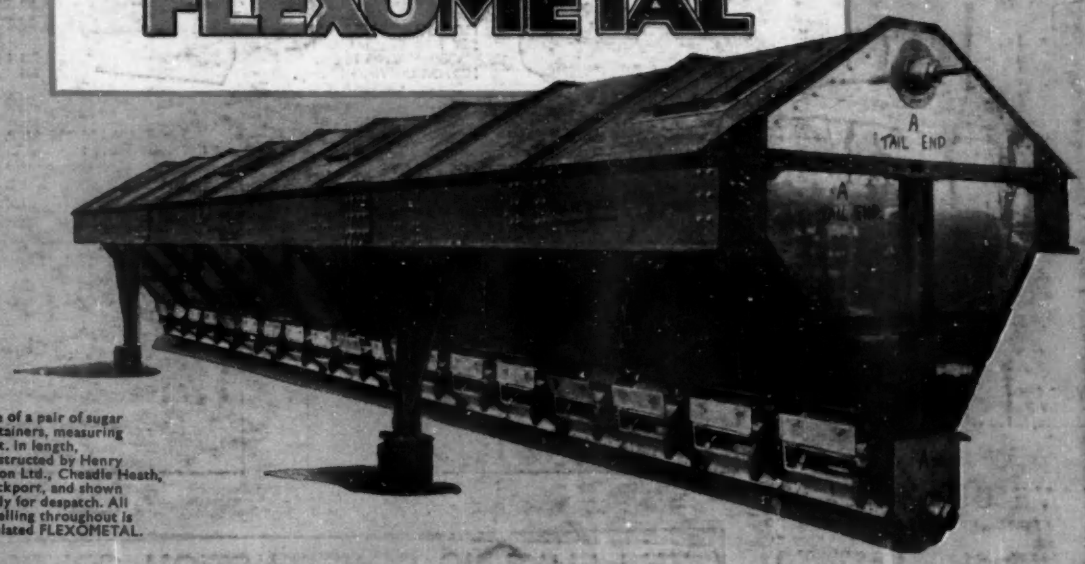

One of a pair of sugar containers, measuring 36 ft. in length, constructed by Henry Simon Ltd., Cheadle Heath, Stockport, and shown ready for despatch. All panelling throughout is insulated FLEXOMETAL.